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# COMPTES RENDUS

## (DOKLADY)

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*MATHÉMATIQUES*

# SUR LES COUPLES DE CONGRUENCES STRATIFIABLES

Par S. BACHVALOFF

*(Présenté par N. N. Lusin, de l'Académie, le 23. X. 1938)*

Deux congruences $L_1$ et $L_2$ à rayons $l_1$ et $l_2$ correspondants sont nommés «couple de congruences stratifiables dans deux directions», s'il est possible d'associer à chacune d'elles $(L_j)$ un système $\sum_j$ de $\infty^1$ surfaces de manière que 1) les plans tangents aux surfaces $\sum_1$ le long du rayon $l_1$ passent par $l_2$ et 2) les plans tangents aux surfaces $\sum_2$ le long du rayon $l_2$ passent par $l_1$.

Soit $L_3$ la congruence des perpendiculaires $l_3$ communes aux rayons $l_1$ et $l_2$ et $N_1$ et $N_2$ — les points d'intersection des rayons $l_1$ et $l_2$ avec $l_3$.

Joignons au système de congruences $L_1$, $L_2$ et $L_3$ un trièdre $T$ dont le sommet $M$ coïncide avec le milieu du segment $N_1N_2$ et les vecteurs unitaires $\bar{I}_1$, $\bar{I}_2$, $\bar{I}_3$ aient la direction des rayons $l_1$, $l_2$, $l_3$.

Les translations d'un tel trièdre sont définis par le système suivant:

$$d\bar{M} = \omega_1\bar{I}_1 + \omega_2\bar{I}_2 + \omega_3\bar{I}_3; \qquad d\bar{I}_j = \omega_{j1}\bar{I}_1 + \omega_{j2}\bar{I}_2 + \omega_{j3}\bar{I}_3 \qquad (j = 1, 2, 3).$$

Les formes différentielles $\omega_i = a_i du + b_i dv$, $\omega_{i,j} = a_{i,j}du + b_{i,j}dv$ vérifient les conditions:

$$\omega_{11} = -p\omega_{12}, \quad \omega_{22} = -p\omega_{21}, \quad dp = (1-p^2)(\omega_{12} + \omega_{21}), \tag{1}$$

$$\omega_{31} + p\omega_{32} + \omega_{13} = 0, \quad \omega_{31} \cdot p + \omega_{32} + \omega_{23} = 0. \tag{2}$$

Dans ces équations $p = \bar{I}_1\bar{I}_2 = \cos\omega$.

Si $L_1$ et $L_2$ sont des congruences stratifiables dans deux directions, il faut ajouter à (1) et (2) le système suivant:

$$[\omega_3 - da,\ \omega_{13}] + [2a\omega_{12},\ \omega_{23}] = 0; \quad [\omega_3 + da,\ \omega_{23}] + [-2a\omega_{21},\ \omega_{13}] = 0; \tag{3}$$

$$[\omega_1 - a\omega_{31},\ \omega_3 + da] + [\omega_2 + a\omega_{32},\ 2a\omega_{21}] = 0;$$

$$[\omega_2 + a\omega_{32},\ \omega_3 - da] + [\omega_1 - a\omega_{31},\ -2a\omega_{12}] = 0; \tag{4}$$

$$-[\omega_1\omega_{13}] + [\omega_2\omega_{23}] = 0; \tag{5}$$

$$[da\omega_3] + [\omega_{12}\omega_{21}] \cdot 2a^2 = 0, \tag{6}$$

où $2a = N_1N_2$.

On considère dans la présente Note le cas défini par les conditions:

1) $da = 0$,

2) $dp = 0$.

Il suit de la condition $dp = 0$ et des équations (1—5) que l'on a

$$\omega_{12} = -\omega_{21} = k\omega_1 - l\omega_2 \tag{7}$$

et

$$\omega_{13} = u\omega_1 + v\omega_2, \quad \omega_{23} = -v\omega_1 - w\omega_2. \tag{8}$$

En posant $\omega_3 = s\omega_1 + t\omega_2$ et en substituant les valeurs $\omega_3$, $da$, $\omega_{13}$, $\omega_{23}$, $\omega_{12}$, $\omega_{21}$ dans les équations (3), on obtient:

$$2a(kw + lv) = sv - tu, \quad 2a(kv + lu) = sw - tv. \tag{9}$$

Deux cas sont possibles: 1) $uw - v^2 = 0$, 2) $uw - v^2 \neq 0$.

1) Si $uw - v^2 = 0$, la congruence $L_3$ est formée de droites ayant une même direction.

2) Si $uw - v^2 \neq 0$, on détermine des équations (9)

$$s = 2a\,\frac{(wv - uv)\,k + (v^2 - u^2)\,l}{v^2 - uw}; \quad t = 2a\,\frac{(w^2 - v^2)\,k + (vw - uv)\,l}{v^2 - uw}. \tag{10}$$

En substituant les valeurs de $s$, $t$ et des formes $\omega_3$, $da$, $\omega_{31}$, ... dans les équations (4), nous obtenons

$$(w - u)\cdot(wk + vl) = 0, \quad (w - u)\cdot(vk + ul) = 0. \tag{11}$$

Le cas $uw - v^2 = 0$ a été déjà considéré; si $wk + vl = 0$ et $vk + ul = 0$, on a $k = l = 0$, $\omega_{12} = \omega_{21} = 0$, $\omega_3 = 0$.

Il suit de la condition $\omega_{12}' = 0$ que $uw - v^2 = 0$, ce qui contredit à l'hypothèse faite.

Si dans les conditions (11) on a $w = u$, alors

$$\omega_{13} = u\omega_1 + v\omega_2, \quad \omega_{23} = -v\omega_1 - u\omega_2. \tag{12}$$

En substituant $w = u$ dans (10), on obtient

$$s = 2al, \quad t = -2ak. \tag{13}$$

En changeant les notations, nous obtiendrons pour $\omega_{ik}$ les valeurs suivantes:

$$\omega_{31} = A\omega_1 - B\omega_2, \quad \omega_{32} = B\omega_1 - A\omega_2, \quad \omega_{12} = k\omega_1 - l\omega_2, \quad \omega_{21} = -k\omega_1 + l\omega_2;$$
$$\omega_{13} = -(A + pB)\,\omega_1 + (B + pA)\,\omega_2, \quad \omega_{23} = -(Ap + B)\,\omega_1 + (Bp + A)\,\omega_2;$$
$$\omega_{11} = -p\omega_{12}, \quad \omega_{22} = -p\omega_{21}, \quad \omega_3 = 2a\,(l\omega_1 - k\omega_2).$$

En dérivant ce système extérieurement, nous concluons, en considérant le système obtenu, que la solution du problème dépend de 4 fonctions d'un argument.

Considérons quelques propriétés de ces couples.

Prenons sur chacun des rayons $l_3$ deux points $N_1'$ et $N_2'$ symétriques par rapport à $M$ et tels que la distance $N_1'N_2' = 2a'$, où $a'$ est une constante; menons par ces points des droites $l_1'$ et $l_2'$, perpendiculaires à $l_3$, et définissons les vecteurs unitaires $\bar{l}_1'$ et $\bar{l}_2'$ des droites $l_1'$ et $l_2'$ par les conditions:

$$\bar{l}_1' = \frac{\bar{l}_1 + \lambda\bar{l}_2}{\sqrt{1 + 2\lambda p + \lambda^2}}, \quad \bar{l}_2' = \frac{\bar{l}_1\lambda + \bar{l}_2}{\sqrt{1 + 2\lambda p + \lambda^2}}, \tag{14}$$

$$\frac{a'}{a} = \frac{1 - \lambda^2}{1 + 2\lambda p + \lambda^2}. \tag{15}$$

Il est facile à voir que les congruences des rayons $l_1'$, $l_2'$ sont stratifiables dans deux directions.

On déduit de l'équation (15) pour chaque $a'$ deux valeurs de $\lambda$ correspondant à deux congruences stratifiables différentes $(L_1', L_2')$ et $(L_1'', L_2'')$; d'ailleurs, les rayons $l_2'$, $l_1'$ sont respectivement orthogonaux aux rayons $l_1''$, $l_2''$.

L'équation (15) peut encore être présentée dans la forme

$$\frac{a'}{a} = \frac{\sin\omega'}{\sin\omega},$$

où $\omega'$ est l'angle entre deux rayons correspondants.

Dans un article précédent [1] nous avons considéré un cas particulier de ces couples de congruences.

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LITTÉRATURE CITÉE

[1] S. Bachvaloff, C. R. Acad. Sci. URSS (1937).

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*PHYSICS*

# ON THE BACK-RAY SHOWERS

By N. DOBROTIN, N. IWANOVA and B. ISAJEV

*(Communicated by S. I. Wawilow, Member of the Academy, 27. X. 1938)*

In 1932 Rossi found the number of coincidences produced by cosmic rays in three counters to increase not only when the lead was placed above the latter, but when it was placed under them too. Later on those back-ray showers were investigated by Fünfer (1), Heidel (2), Gilbert (3) and Hosemann (4). They showed that the dependence of the number of back-ray showers on the thickness of the lead placed under the counters can be expressed by a curve with saturation setting in, say, at 0.6 cm of Pb. The number of back-ray showers, which is also dependent on the substance placed under the counters, is increasing linearily with the increase of $Z$. This circumstance enabled Heidel and Hosemann to evaluate the order of energy magnitude of the radiation, responsible for the back-ray showers. While using plates of Al as interlayers between the counters and the lead, placed under them, Heidel and Hosemann found for the absorption coefficient of this radiation the value 1—3 $cm^{-1}$ Al. Taking the radiation for $\gamma$-rays, they evaluated the energy of a photon as $10^5$—$10^6$ eV.

According to Gilbert's data, the dependence of the number of back-ray showers on the thickness of lead placed above the counters obeys the usual Rossi curve for direct showers. This is confirmed by the experiments by Fünfer, Heidel and Hosemann, who also found that the number of back-ray showers increases 2.5—6 times, 15 mm Pb being placed above the counters.

In Heidel and Hosemann's experiments the number of back-ray showers proved to be as high as 40—50% of the number of direct showers when lead was placed above the counters.

It may be shown that all the above experimental data defy interpretation on the basis of all we know about the mechanism of production of secondaries by cosmic rays. In fact, it follows from the theory developed by Bhabha and Heitler (5) that the photons of the collision radiation are practically emitted in the direction of the radiating particle. Particles of pairs with large energy, forming in the case of absorption of this collision radiation, are also forming small angles with the direction of the photons they are produced by. This is the cause why the usual cascade mechanism of shower formation cannot result in the formation of upward projected particles. The photons of the collision radiation, which originates in the case of absorption of shower particles in the lead placed above the counters, can neither produce secondary back-ray electrons. Besides, the number of such photons

of collision radiation would prove too small to account for the percentage of back-ray showers observed*.

The back-ray showers can neither be explained by the annihilation radiation, arising in the lead at the expense of the positrons present in the showers. In the latter case, if we neglect the energy loss by positrons through radiation, as well as the photoeffect (which is at any rate true of lighter elements, investigated by Heidel and Hosemann), then, the thickness of the layer being sufficient, the number of back-ray showers should not depend on the atomic number of the substance, placed above the counters. This is, however, at striking variance with the experimental data. It may also be readily seen that the back-ray showers can neither be accounted for by simple scattering of shower particles, as described by the well-known Mott formula.

Thus, to interpret the formation of back-ray showers one is obliged to look for new, still unknown mechanisms. Owing to this circumstance, the study of back-ray showers assumes a high theoretical importance.

In this connexion in summer 1938 we undertook experiments with back-ray showers at an altitude of 3000 m above the sea level (Elbrouz, Caucasus). For this work we had recourse to an apparatus consisting of two groups of p r o p o r t i o n a l counters, switched into the coincidence scheme we had described elsewhere (4). To eliminate coincidences due to heavy particles, between the counters were placed interlayers of Al, the thickness of which corresponded to 0.55 g/cm².

Throughout the experiments the thickness of lead under the counters was kept constant (15 mm). The dependence of the number of back-ray showers on the thickness of Pb and Al above the counters was investigated. The results of these experiments are tabulated below.

| Thickness of the substance above the counters | 0 | Pb, 0.2 cm | Pb, 0.8 cm | Pb, 1.5 cm | Al, 3.2 cm |
|---|---|---|---|---|---|
| Number of back-ray showers per 3 min. | 4.4±0.4 | 3.8±0.6 | 4.1±1.0 | 1.3±1.7 | 0.8±0.8 |
| % of back-ray showers to direct ones | 13 | 9 | 7 | 2 | 2 |

From this table it may be seen that there exists a striking discrepancy between our results and the data obtained by other authors. When working with usual counters, the number of back-ray showers was markedly increased by placing above them 15 mm Pb, while in our experiments this procedure resulted in a reduction of the number of back-ray showers. The same result was obtained by placing above the proportional counters 3.2 cm Al.

The fact that Gilbert (3) who made his experiments at an altitude of 3500 m obtained a qualitatively similar result with the authors who were experimenting at the sea level, points to that this discrepancy can hardly be referred to the dependence of the nature of back-ray showers on the height of the spot of observation. In the experiments of Heidel (2) and Hosemann (4) all the three counters were situated on a horizontal plane, while Fünfer (1) and Gilbert (3) placed them in triangle. In spite of this, the results obtained by all these authors are qualitatively similar. This points to the fact that the disagreement we are dealing with cannot be referred to the difference

* Even if we take into account that a back-ray shower may consist of several particles, projected from above, and a single particle directed upward from below.

in the geometrical conditions of the experiments either. It may be assumed that the properties of back-ray showers are largely dependent on the size of the showers observed. In the experiments with usual Geiger-Müller counters the operation of the arrangement can be caused by 3, sometimes even by 2 simultaneous particles. On the other hand, the sensitivity of the proportional counters of the arrangement we used for our experiments was such, that the apparatus was operating in the case of a simultaneous hitting by at least 10—12 particles. The contradiction observed may therefore be explained on the assumption that among the showers with a small number of particles are prevailing showers, the number of which is increased by placing lead above the counters; and, on the contrary, that among large showers predominate such back-ray showers, whose number is reduced when lead is placed above the counters.

Besides at an altitude of 3000 m, we carried out a series of experiments with the determination of the number of back-ray showers also at altitudes of 4200 and 5300 m above the sea level. It proved thereby that the ratio of back-ray showers to the direct ones remains about the same at all the three altitudes. This points to the fact that the back-ray showers are connected with the soft component of the cosmic radiation. However, the data obtained at high altitudes seem to be less reliable than those secured at the height of 3000 m; the above conclusion requires therefore to be experimentally checked.

Thus, our experiments show that the phenomenon of back-ray showers should be regarded as a complex process, in which various mechanisms of production of secondary particles may be involved. It may be that Heidel and Hosemann's conclusion to the effect that back-ray showers are connected with soft γ-rays and strongly absorbed particles should be referred only to a part of back-ray showers. The rest of them may possibly be explained at the expense of hard γ-rays and strongly penetrating particles. This assumption can be supported by the photographs, obtained by means of a Wilson cloud chamber by D. V. Skobelzyn (7), Blackett (8), and others, these photographs bearing traces of isolated particles with high energy and even of showers, directed upward.

After this note was sent in print, there appeared an article by Schmeiser (ZS. f. Phys., **110**, 443, 1938) stating that showers, formed by the penetrating component and, probably, made up of heavy electrons, may give a tertiary soft and comparatively diffuse radiation. It is probable that the back-ray showers are due to this very radiation.

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REFERENCES

[1] E. Fünfer, ZS. f. Phys., **88**, 92 (1933). [2] E. Heidel, Dissertation, Tübingen (1935); see also H. Geiger, Erg. d. exakten Naturw., **14**, 61 (1935). [3] C. W. Gilbert, Proc. Roy. Soc. A, **144**, 559 (1934). [4] R. Hosemann, ZS. f. Phys., **100**, 212 (1936). [5] Bhabha a. Heitler, Proc. Roy. Soc. A, **159**, 432 (1937). [6] V. Veksler a. N. Dobrotin, C. R. Acad. Sci. USSR, XIX, 469 (1938). [7] D. Skobelzyn, C. R. (Paris), **206**, 385 (1938). [8] P. M. S. Blackett a. G. P. S. Occhialini, Proc. Roy. Soc. A, **159**, 702 (1938).

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*GEOPHYSICS*

# ON HELMERT'S FORMULA AND THE ISOSTASY HYPOTHESIS

By N. MALKIN

*(Communicated by S. I. Wawilow, Member of the Academy, 26.X.1938)*

These two theories, which are usually considered indepedently, do to a certain extent complement each other, but at the same time may be developed to such extent as to form independent constructions.

Helmert's formula [1] gives an interpretation of the gravitational anomalies on the geoid by means of the surface layer, the density of which may be considered to be equal to the defect (or the excess) of masses at the given point. It leaves the question on the depths at which the actual masses are situated totally unanswered.

The theory of isostasy, on the contrary, determines only the depth of the isostatical layer, taking the defect of the subterranean masses for granted, i. e. starting from the hypothesis of a complete compensation of the terranean relief.

In many countries, however, only an incomplete compensation takes place [2,3] and, after Heiskanen [(3), p. 179 and 201], the questions as to the extent to which the total mass of the mountains is compensated, and what part of the compensation occurs in the neighbourhood of the earth' surface, can be scarcely solved without the help of geophysicists and geologists.

An approximate answer to the first question is obviously given by Helmert's formula. We can, however, considering the incomplete compensation, also extend the conception of isostasy. Denoting by $H$ and $\delta$ the height and the density of the terranean relief, and by $T$ and $\delta_1$ the depth and the defective density of, say, Pratt-Hayford's layer, we may introduce «the coefficient of compensation» $q$, putting

$$T\delta_1 = \frac{q}{100} H\delta. \qquad (1)$$

For $q=0$ the best result in the sense of destruction of the anomalies gives Bouguer's reduction. The usual isostasy hypothesis (complete compensation) offers a more accurate assertion $q=100$ and then, according to different assumptions on the depths $T$ (by Hayford) or $D$ (by Airy), proceeds to calculations with the number 3 and even up to 10 (Heiskanen for Norway); as the best is considered the assumption which reduces to a minimum (f. i. in the sense of the mean square deviations) the anomalies of the gravitation and the plumb line. However, one supplementary calculation for any value of $T$ and $q \neq 100$ would suffice to contribute to the determination of the probable defect

of the masses, while in the result of two or three such calculations with different $T$ the most probable value of $T$ would change. Moreover, these calculations will not be cumbersome at all, since they may be reduced to multiplication of already obtained results by one and the same factor $g$.

The uncompensated part $(1 - \frac{c}{100})H$ of the relief must be transposed to the centre of the earth: thus, the reduction by $q\%$ will be isostatical and by $100 - q\%$ by Bouguer's method, generalized for the case of the spherical form of the earth [usually this generalization is made in the form of destruction of transported masses, which must be considered as false, and the objection to Bouguer ([4]) based on it, as unfounded: Bouguer himself considered only a plane region of the earth]. Instead of Pratt's hypothesis we can, of course, use more probable ones of Airy and Heiskanen and deduce for each of them **the most probable value of $q$ by the same method.**

We proceed now to deduce a more precise form of Helmert's formula, **and to this end consider a layer of finite thickness $h$.**

Using the integral equation for a layer covering a sphere ([illegible]) and taking into account Bruns's [cf. ([illegible]), p. [illegible], or ([illegible]), p. 18[illegible]] correction for the transition from the sphere to the geoid, we obtain the following formula*:

$$h(\theta,\lambda) = \frac{1}{2\pi k^2 \delta_1}\Delta g(\theta,\lambda) - \frac{1}{4\pi k^2 \delta_1 R}\,gN(\theta,\lambda) + \frac{1}{4\pi}\iint \frac{h^2(\theta,\lambda) - h^2(\theta',\lambda')}{r^3}\,d\sigma' - \frac{h^2(\theta,\lambda)}{R}\;{}^{**}, \qquad (2)$$

where $h(\theta,\lambda)$—the thickness of the layer—is a function of the geographical co-ordinates $\theta$ and $\lambda$, $k^2 = \frac{2}{3}10^{-7}$, $\delta_1$—the density of the layer, $\Delta g$—Bouguer's anomaly (removal of the whole terrestrial relief, say to the [illegible]), $\theta'$ and $\lambda'$—the current co-ordinates of the surface element $d\sigma'$, $r$—the distance between the points $(\theta,\lambda)$ and $(\theta',\lambda')$, $R$—the radius of the earth, $g$—the gravity and $N$—the distance of the geoid from the surface of comparison.

This equation differs from Helmert's formula by the last two quadratic terms on its right hand side, in which we may substitute the value of $h$ obtained in the first approximation from Helmert's formula (the method **of successive approximations**).

Omitting also the term with $gN$, we obtain the usual rough interpretation of anomalies by Bouguer, which (with a simplified calculation of $\Delta g$) is used by geologists [Kosamat, Born and others ([illegible])], but which does not take into account the «boundary effects» (Randstörung). For the investigation of the degree of compensation of Harz and other mountains, where the influence of the alpine compensation is noticeable, Heiskanen proposes to use therefore the isostatical reduction (Hayford's or Airy's). But, as it also follows from the assertions of Heiskanen himself mentioned above, it is scarcely possible to obtain in this way a satisfactory quantitative solution of the problem. In such cases it is better either to determine the coefficient $c$, or to introduce the quadratic terms of the formula (2), the density $\delta_1$ must be then given on ground of geological considerations. If the so obtained layer turns out to be very thin in certain places, this will be an indication that at this place the greater part of the compensation occurs in the neighbour-

---

* **Replacing $g$ of the first formula by $\Delta g$ in the second and $r$ by $\Delta r = gN$.**

** For small regions of the earth the first term on the right hand side of (2) may be neglected and the second term replaced by a constant.

[illegible] of the earth surface to a certain extent it will be thus possible to give an answer to the second of the questions proposed by Heiskanen.

[illegible] will be, of course, schematical, but, as Heiskanen [3]* [illegible], in such cases we must somewhat simplify and schematize [illegible], since otherwise we shall have to determine too many parameters [illegible].

If we consider the theory of isostasy as a hypothesis to be verified, the formula [illegible] may be used for this purpose [illegible] as well as the determination of the coefficient $q$)**.

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[illegible]

REFERENCES

[illegible] [2] Heiskanen, [illegible] [4] Heiskanen, Beiträge zur Geophysik, 26 [illegible] [illegible] [illegible] фигуры земли [illegible].
[5] Н. Малкин, Тр. Физ.-мат. ин-та им. Стеклова. II, 4.

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* [illegible] in Harz an excess of masses, but Heiskanen [illegible] this method.

** [illegible] of the gravity given. If we consider it as known only with the precision to the constant [illegible] owing to the not exactly known normal gravity, we shall obtain [illegible] in the formula [illegible] as well as for the usual [illegible] formula, also with the precision to the constant; $q$ is also exposed to analogous influence.

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AGROCHEMISTRY

# EFFECT OF NaCl AND $Na_2SO_4$ SALTS ON SUGAR CONTENT IN MELONS

By A. S. MOROZOV

(Communicated by [illegible], Member of the Academy, [illegible])

Commercial growing of plants on soils of different salinity is a very complicated problem, now assuming a new significance in connection with the task of mitigating drought and obtaining high yields. The study of salt resistance of melons, especially of water-melons, deserves special attention. The works by B. Pavlov (1) have proved that the water-melon as predecessor of summer wheat in crop rotation should become widely popular since it splendidly solves the problem of enhancing yield by the methods of dry cultivation in regions in which drought is prevalent. Apart from its excellent qualities as food article, the melon, so to speak, is a kind of peculiar sugar mill, since it supplies us with raw material to produce water-melon treacle, sweetmeats and other articles of confectionery. Comparatively small attention has, however, been paid in the literature to the question concerning the salt resistance of melons. Nothing but two works are to be mentioned here. A. Werner and N. Pogosov (2) have carried out laboratory experiments with melon seedlings. Their experiments were not conducted in the open and are fit to excite but a curiosity rather than satisfy it. The work performed by Ivanovsky (3) presents an exceptional interest. The major parts of it were done using inadequate methods and the conclusions drawn from such a material need thorough verification. So it is with the question of sugar content in water-melons. The fruits subjected by Ivanovsky to analysis had ripened to different degree and were sometimes not ripe at all. It is therefore obvious that the statement advanced by Ivanovsky as to the sugar content of water-melons going up with the increase of soil salinity ought to be reexamined. This was done in Bykovsky melon-station. The action of chlorides and sulphates of the soil was tested in vegetation experiments. The rates of the salts varied within the following limits:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.1 mole, soil water being taken into account | | | | | | | |
| 0.2 | » | » | » | » | » | » | » |
| 0.3 | » | » | » | » | » | » | » |
| Control | | | | | | | |

Recalculated to absolutely dry soil, these figures should be expressed as follows (Table 1).

Table 1

| Variant of salting | Amount of salt in % of absolutely dry weight of soil | |
|---|---|---|
| | NaCl | $Na_2SO_4$ calculated for the salt with water of crystallization |
| Control | — | — |
| 0.1 mole | 0.127 | 0.706 |
| 0.2 » | 0.255 | 1.413 |
| 0.3 » | 0.382 | 2.121 |

There were four parallel sets of experiments. The sugars were estimated according to Bertrand. The fruit was cut in two, the pulp from one of the halves was put into a linen bag and the juice pressed out by hand. The cut passed from the basal to the apical end of the fruit, so that both the shady (turned to the ground) and the sunlit (upper) sides of the latter entered in the sample to be tested. The fruits taken for analysis were of the same age, ranging between 46 and 48 days. The pulp was bright red, no unripe fruits were used. The juice pressed out and diluted respectively was subjected to analysis. Its purifying with lead acetate was omitted as superfluous. The results of analysis are summarized in Tables 2 and 3.

Table 2

Sugar Content of Water-Melon «Melitopolsky 142» in Different Salting Variants

| Salting variant | Amount of salt in mole | Age of fruit in days | Total sugar in % | Monosaccharides in % | Sucrose in % |
|---|---|---|---|---|---|
| Control | — | 46 | 7.01 | 4.82 | 2.19 |
| NaCl | 0.1 | 46 | 6.43 | 4.48 | 1.95 |
| NaCl | 0.2 | 46 | 3.72 | 2.97 | 0.75 |
| $Na_2SO_4$ | 0.1 | 46 | 6.29 | 4.11 | 2.18 |

From Table 2 one may conclude that the sugar content was higher in plants which had been given no salts. This is true not only of the total content of sugar, but also of the amount of monosaccharides and sucrose. The salting with 0.1 mole reduced the content of sugar both in chloride and sulphate variants, the former being more conspicuous in that respect. With 0.2 mole the sugar content was reduced still more. This concentration was tested only in the chloride variant.

As regards the musk-melon, the results obtained were as follows (Table 3).

Table 3

Sugar Content of Musk-Melon «Kassaba pyatnistaya» in Different Salting Variants

| Salting variant | Amount of salt in mole | Age of fruit in days | Total sugar in % | Monosaccharides in % | Sucrose in % |
|---|---|---|---|---|---|
| Control | — | 47 | 7.16 | 5.50 | 1.66 |
| NaCl | 0.1 | 47 | 5.76 | 2.29 | 3.47 |
| $Na_2SO_4$ | 0.1 | 48 | 6.28 | 1.75 | 4.53 |

The total sugar content of musk-melon goes down as salting goes up. The same is observed with regard to monosaccharides. As to sucrose there is a great difference between water-melon and musk-melon. The latter when given salts increase their content of sucrose, while the former respond to the salting contrariwise.

The following conclusions may be drawn from the work here reported:

1. Salting of soil lessens the quality of fruit by reducing its sugar content and size.

2. The water-melon proved to be more resistant than the musk-melon as regards the salinity of soil.

3. Both the water-melon and musk-melon agree with chlorides better than with sulphates.

Bykovsky Experimental
Station for Melon-Breeding.

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REFERENCES

[1] Д. С. Певнев, Тр. Быковск. оп. ст. бахчеводства, вып. 1 (1933). [2] А. Р. Вернер и Н. С. Бугаев, там же, вып. 2 (1935). [3] В. Д. Знаменский, Тр. ВИР'а, XXIII, вып. 3 (1929—30).

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BIOCHEMISTRY

# ON THE ACCUMULATION OF BIOGENIC ELEMENTS (NUTRIENT SALTS) IN MUD WATER OF FRESH-WATER BASINS

By S. W. BRUJEWICZ, R. M. PEVZNIAK, V. L. PONIZOVSKAJA and M. A. SIBIRJAKOV

(Communicated by W. I. Vernadsky, Member of the Academy, 2. X. 1938)

Among the abundant material available on the chemistry of water and the general chemical composition of the bottom fresh-water sediments, almost no attention has been given up to the present time to the chemical composition of the fresh-water slime solutions; at least works even slightly touching upon this subject are very scarce (2, 4, 5). The influence of bottom sediments, in the first place of the slime water, on the chemical aspect of the water mass, has been always assumed a priori in limnology. In the Soviet Union the importance of studying the «slimy» or «muddy» waters has been repeatedly emphasized by W. I. Vernadsky, Member of the Academy, who has introduced into his own classification of natural solutions as a separate family the «slime and mud waters», in particular «mud waters of fresh-water lakes» (3). As far as we know, the present work is the first attempt of a systematic study of the content and dynamics of biogenic elements in a mud solution (not in the extract of mud) along the vertical according to the seasons of the year.

As material we have chosen the eutrophic Lake Bisserovo near Moscow with its extremely thick and loose bottom sediments of the sapropel type. The area of the lake is about 100 hectares, the average depth—about 1.75 m. The lake has no tributaries. The ground feeding is compensated by the issue of the small [illegible] river. In July of 1936 a most intensive development of [illegible], Anabaena and *Microcystis* was observed. The bottom sediments consist chiefly of greenish-brown algaean gyttja with clearly discernible elements of the prevailing forms of phytoplankton in the upper layer, altered to a detritus mass in the lower one. The average layers of dry matter in the sample taken from a depth of 25 cm, 50 cm and about 75 cm is 1.68%, 1.85% and 4.91% respectively. Water samples were taken by means of Ruttner's water-bottle for the water and the two upper layers of liquid mud (25—50 cm below the bottom), by the Brujewicz' disc water-bottle for the bottom layer proper and by a bottom-sampler of the type employed at the Kossino Limnological Station for the mud at a depth about 75 cm below the bottom surface. The mud solution was obtained by squeezing. For the methods of chemical analyses see (1).

Table 1 contains average values summarized for a number of stations and referring to the chief layers and all the four seasons (1936—1937).

The principal conclusions may be briefly stated as follows: with regard to all the chemical components as far as it is possible under the existing physico-chemical conditions, a considerable accumulation may be observed in the mud solution as compared to that in the bottom-water; this accumulation increases with the depth of the mud. Exceptions are: oxygen, nitrates, partly

Table [illegible]

Physical Properties and Chemical Composition of Water and Mud Liquor from the Lake [illegible] in [illegible] and [illegible]

| Date [illegible] | Water: surface | Water: bottom layer | Mud layer under the surface of mud: 25 cm | 50 cm | 75 cm |
|---|---|---|---|---|---|
| **Temperature °C** | | | | | Air |
| July, 1st half | 25.0 | 23.4 | 22.3 | 21.6 | 25.3 |
| » 2nd » | 25.5 | 23.8 | 22.3 | — | 21.3 |
| October | [illegible] | [illegible] | 2.7 | — | 2.5 |
| November | [illegible] | [illegible] | — | — | [illegible] |
| March | [illegible] | [illegible] | [illegible] | — | [illegible] |
| April | [illegible] | [illegible] | [illegible] | — | — |
| **Colour in degrees of Pt—Co scale** | | | | | |
| July | 25 | 28 | 31 | 35 | 42 |
| October-Nov. | 15 | 17 | 15 | 15 | [illegible] |
| March | [illegible] | [illegible] | [illegible] | — | [illegible] |
| April | [illegible] | [illegible] | [illegible] | — | [illegible] |
| **Alkalinity without correction for ammonia, mg-equiv. per litre** | | | | | |
| July | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| October-Nov. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| March | [illegible] | [illegible] | [illegible] | — | [illegible] |
| April | [illegible] | [illegible] | [illegible] | — | [illegible] |
| **Alkalinity minus ammonia, mg-equiv. per litre** | | | | | |
| July | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| October-Nov. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| March | 1.25 | 1.24 | [illegible] | — | [illegible] |
| April | 0.94 | 1.11 | 0.85 | — | 1.04 |
| **pH** | | | | | |
| July | 9.20 | 8.95 | 7.22 | [illegible] | [illegible] |
| October-Nov. | [illegible] | [illegible] | [illegible] | 6.93 | [illegible] |
| March | [illegible] | [illegible] | [illegible] | — | — |
| April | [illegible] | [illegible] | [illegible] | — | — |
| **Oxygen saturation $O_2$ %** | | | | | |
| July | [illegible] | 86 | — | — | — |
| October-Nov. | 81 | 76 | — | — | — |
| March | [illegible] | [illegible] | — | — | — |
| April | 104 | 85 | 86 | — | — |
| **Nitrate N, mg per litre** | | | | | |
| November | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| March | [illegible] | [illegible] | [illegible] | — | [illegible] |
| April | [illegible] | [illegible] | [illegible] | — | [illegible] |

Table 1 (continued)

| Date (1936—37) | Water | | Mud ligase under the surface of mud | | |
|---|---|---|---|---|---|
| | surface | bottom layer | 25 cm | 50 cm | 75 cm |
| **Nitrite N mg per litre** | | | | | |
| July | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| October-Nov. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| March | [illegible] | [illegible] | [illegible] | — | [illegible] |
| April | [illegible] | [illegible] | [illegible] | — | [illegible] |
| **Ammonia N mg per litre** | | | | | |
| July | — | [illegible] | [illegible] | [illegible] | [illegible] |
| October-Nov. | — | [illegible] | [illegible] | [illegible] | [illegible] |
| March | — | [illegible] | [illegible] | — | [illegible] |
| April | — | [illegible] | [illegible] | — | [illegible] |
| **Organic nitrogen N, mg per litre** | | | | | |
| March | [illegible] | 5.8 | 12.6 | — | [illegible] |
| April | [illegible] | 2.6 | 3.9 | — | [illegible] |
| **Phosphate P, mg per litre** | | | | | |
| July | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| October-Nov. | 0.060 | [illegible] | [illegible] | [illegible] | [illegible] |
| March | [illegible] | [illegible] | [illegible] | — | [illegible] |
| April | [illegible] | [illegible] | [illegible] | — | [illegible] |
| **Organic phosphate P, mg per litre** | | | | | |
| March | 0.062 | [illegible] | [illegible] | — | [illegible] |
| April | 0.017 | [illegible] | [illegible] | — | [illegible] |
| **Ratio of organic nitrogen to organic phosphorus, N:P** | | | | | |
| 1937: 9 III, st. 1 | 44 | — | 24 | — | — |
| 13 III, st. 3 | 44 | [illegible] | [illegible] | — | [illegible] |
| 25 III, st. [illegible] | [illegible] | (225) | 228 | — | [illegible] |
| 28 III, st. [illegible] | [illegible] | 81 | 50 | — | [illegible] |
| 30 III, st. [illegible] | [illegible] | 88 | (470) | — | — |
| **Silicon Si mg per litre** | | | | | |
| July | [illegible] | 3.2 | 4.7 | 6.1 | [illegible] |
| October-Nov. | 5.4 | 5.3 | 5.5 | 7.[illegible] | 14.2 |
| March | [illegible] | [illegible] | [illegible] | — | 10.4 |
| April | 3.4 | 3.1 | 3.6 | — | 12.[illegible] |
| **Ferrous oxide $Fe^{++}$, mg per litre** | | | | | |
| July | [illegible] | 1.3 | 2.3 | 9.0 | [illegible] |
| October-Nov. | 1.0 | 5.0 | 2.7 | 7.4 | 22.4 |
| March | [illegible] | [illegible] | [illegible] | — | [illegible] |
| April | [illegible] | [illegible] | [illegible] | — | [illegible] |

Table 1 (continued)

| Date 1936—1937 | Water | | Mud liquor under the surface of mud | | |
|---|---|---|---|---|---|
| | surface | bottom layer | 25 cm | 50 cm | 75 cm |
| **Chloride Cl, mg per litre** | | | | | |
| July | 1.8 | 1.8 | 4.9 | 4.6 | 10.1 |
| October-Nov. | 2.9 | 3.6 | 5.2 | 5.8 | 9.0 |
| March | [illegible] | [illegible] | [illegible] | — | [illegible] |
| April | (1.1) | (1.2) | (1.7) | — | (2.0) |
| **Oxygen consumed from permanganate $O_2$, mg per litre** | | | | | |
| July | 22 | 22 | 30 | 33 | 50 |
| October-Nov. | 19 | 21 | 25 | 32 | [illegible] |
| March | 7 | 6 | 7[illegible] | — | [illegible] |
| April | 5 | 6 | 13 | — | 14 |

Note. The measurements made in March characterize the conditions in winter—the lake still covered with ice; those made in April—the conditions in spring after the melting of ice.

nitrites, phosphates and sulphates. The accumulation of phosphates is limited by the influence of iron owing to the formation of poorly soluble iron phosphate.

In summer-time the difference in the content of biogenic elements in the bottom layer and the upper layer of mud is rather small, and by far less than towards the close of the winter, though the mid-waters are thoroughly warmed and the washing out of the mud sediments by the water is insignificant. This points to the fact that in summer the decomposition of the freshly deposited vegetable material in the upper layer of mud proceeds but slowly and the regeneration is observed chiefly for carbon and nitrogen in the form of ammonia.

In autumn the cooling of the water and the setting in of vertical circulation produce an equalization of the chemical composition within the water layers which involves the upper layer of mud. The difference between concentrations of the biogenic elements in the bottom water layer and the upper layer of mud decreases to a considerable extent as compared to that observed in summer-time. Considerable nitrification is observed in the upper layer of mud.

The biogenic element content in the water layers increases at the expense both of regeneration from solved substances and the washing out from bottom sediments. Autumn is the time of the most intense influence of the bottom sediments on the water layers. Calculations show that the amount of ammonia nitrogen passing within the transitional period from summer to autumn from mud to the mid-waters reaches 820 mg N per $m^2$ of the bottom area, or 1.2 mg N per litre of mid-waters.

Processes of regeneration of biogenic elements from organic substances are steadily developing in the lower layers; for nitrogen these processes are chiefly confined to ammonification.

In winter the processes of regeneration of biogenic elements and of oxidation of organic substance go on, consuming the greater part of the oxygen resources of the basin. In the course of the late-autumn and early-winter circulation the water layers become enriched in Ca and Mg salts

(alkalinity), carbonic acid, nitrates, ammonia, partly nitrites and silicon. At the expense both of iron oxidation and iron phosphate precipitation, the content of both these ions in the water layers is reduced. Owing to the relatively resting state of water during winter-time, the products of regeneration of biogenic elements remain in the mud which results in rather different concentrations of the bottom layer and the upper layer of mud, especially with regard to colour, oxygen consumed from permanganate, nitrates, ammonia, phosphates, ferrous oxide and, probably, oxygen. Thus, it is evident that in winter the influence of the mud sediments on the basin is markedly lessened as compared to the period of autumn. A sharp intensification of colour and oxygen consumed takes place in the deep mud layers; to a lesser extent increases the content of nitrates, nitrites, ammonia, phosphates, chlorides. Nitrification in the upper layer of mud is widely developed.

In spring, after the melting of ice and with the beginning of vertical circulation, may be observed an intensive washing out of the mud sediments by circulating water which results in a sharp decrease of biogenic element concentration in the bottom layer and the upper ground layer, with regard to colour, oxygen consumed, alkalinity, ammonia, organic nitrogen, mineral and organic phosphorus, silicon and iron. The washing out of slimes in spring tells also upon the deep layers, where colour and oxygen consumed become less intense, while alkalinity, nitrites, ammonia, organic nitrogen, mineral and organic phosphorus, silicon and iron are reduced to a lesser extent. Thus, with regard to the washing out of muds the spring circulation is characterized by a much stronger effect of the mud sediments on the basin than the autumn circulation. The set in of photosynthesis and of the biological consumption of biogenic elements prevented us from direct recognition of the increase of concentration of biogenic elements in the basin in springtime as compared to the fall. The decrease of the content of biogenic elements in the mud solution taking place after the set in of spring circulation permits of an approximate calculation of the amount of biogenic elements, which passed from the mud into bottom water (Table 2).

Table 2

| | Per 1 m² of the bottom area | Per 1 litre of water | Average content in the basin at the end of March, mg/l |
|---|---|---|---|
| Nitrate nitrogen | 27.5 | 0.04 | 0.46 |
| Ammonia nitrogen | 870 | 1.2 | (1.89) |
| Organic nitrogen | 2050 | 2.9 | 4.6 |
| Phosphate phosphorus | 11.2 | 0.016 | 0.011 |
| Organic phosphorus | 10.0 | 0.014 | 0.054 |
| Silicon | 1820 | 2.6 | 6.2 |

The transportation from the bottom sediments to the mid-waters occurring in the spring plays an important part in relation to ammonia and organic nitrogen, phosphates and silicon, and a less essential part with regard to nitrates and organic phosphorus.

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9. X. 1938.

REFERENCES

[1] С. В. Бруевич, Б. А. Скопинцев и С. М. Драчев, Сб. работ Центр. н.-и. ин-та коммун. санит. и гигиены, НКЗ, № 18 (1936). [2] В. И. Вернадский, История минералов земной коры, 2, История природных вод, ч. 1, вып. 1 (1933). [3] А. Д. Пельш, Природа, № 3, 16 (1935). [4] А. К. Трифонов, Тр. Бород. биологич. ст., VII, вып. 3 (1935). [5] H. G. Bank, Gesundheitsing., **56**, 13, 150 (1933).

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*HYDROBIOLOGIE*

# KASPISCHE RELIKTE IN DER FAUNA DER UZBOJ-SEEN

Von A. L. BEHNING

*(Vorgelegt von S. A. Zernov, Mitglied der Akademie, d. 13.IX.1938)*

Die «Süsswasserseen» des alten Uzboj-Strombettes—Jaschan, Karatogelek und Topjatan—erregten schon seit langem das Interesse der Asienforscher, ihre Hydroflora und Hydrofauna bleiben jedoch bis heute nur ungenügend erforscht.

Bis vor kurzem, dank den Arbeiten von Sievers (10), Nikolsky (7), Stebnitzkij (11), Gluchovskoj, Warentzov (12), Berg (3), Bulgakov (4), und Moltschanov (6), kennen wir aus diesen Seen folgende Vertreter ihrer Hydrofauna.

Jaschan: *Neritina*, *Dreissena*, *Planorbis*, *Gammarus*, *Rutilus rutilus uzboicus*, *Abramis brama*, *Cyprinus carpio*, *Silurus glanis*, *Perca fluviatilis*.

Karatogelek: *Dreissena*, *Lymnaeidae*, *Bryozoa*, *Rana esculenta*, *Cyprinus carpio*.

Topjatan: *Rutilus rutilus uzboicus*, *Cyprinus carpio*, *Atherina mochon. pontica caspia*, *Pungitius platygaster* *, *Emys orbicularis*.

Diese, wenn auch durchaus spärliche Angaben zeigen, dass dieser See ohne Zweifel von einer Reihe kaspischer Vertreter bewohnt ist, deren genauere Erforschung von bedeutendem Interesse wäre. Deshalb war ich gerne bereit eine kleine Kollektion von daselbst durch I. W. Starostin (Expedition der Turkmenischen Zoologischen Station in Aschchabad, 1936) eingesammelten Wasserbewohnern zu untersuchen.

In diesem Material konnte ich folgende kaspische Reliktenformen feststellen.

1. *Theodoxus pallasi* Lindholm. Jaschan-See, 13. VIII. 1936 (Käscher am Boden), einige Exemplare.

2. *Theodoxus danubialis* C. Pf.? Jaschan-See, 13. VIII. 1936 (Käscher am Boden), 2 Exemplare, welche B. M. Alexandrov, der dieses Material geprüft hat, mit einem? zu dieser Art zuzählt.

3. *Dreissena polymorpha* Pallas. Jaschan-See, 13. VIII. 1936 (Käscher am Seeboden), eine grosse Anzahl von 8.2 bis 21.2 mm lange Exemplare.

4. *Dikerogammarus haemobaphes* (Eichw.). Jaschan-See, 30. VIII. 1935 (Käscher am Seeboden), 8 ♂, 12 ♀; daselbst, 13. VIII. 1936 (Käscher im Ufergewächse), 12 ♂, 4 ♀, 3 juv., I. W. Starostin.

Die Länge der erwachsenen ♂ ist 15—17 mm gleich, diejenige der ♀—10—13 mm; die Nebengeissel besteht aus: beim ♂—6—8 und beim ♀—5—7 Gliedern. Somit erscheinen die uzbojschen Tiere, ihrer Grösse nach zu urteilen, im Vergleich zu denjenigen vom unteren Don (5) und der Wolga (2) etwas

* Diese Art wurde von L. S. Berg im Moltschanov'schen Material gefunden. Für die freundliche Erlaubnis diese Angaben hier zu veröffentlichen bin ich Prof. L. S. Berg zu grossem Dank verpflichtet.

geringer, und stehen vielmehr den kaspischen näher ([illegible]). Weibchen mit Eiern im Brutraum wurden sowohl in den März- als auch in den Augustproben gefunden.

5. *[illegible]* (Grimm MS) Sars. Jaschan-See. 1[illegible]. VIII. 19[illegible] (Kescher im Ufergewächs). 1 ♀ mit Eiern. I. W. Starostin. Die Länge des einzigen Weibchens beträgt 7 mm, die Nebengeissel besteht aus 4 Gliedern. Die Augen sind relativ gross. Im allgemeinen entspricht das Exemplar der Sars'schen Beschreibung.

Das Auffinden dieser Art in den europäischen Gewässern ist von besonderem Interesse, da dieselbe weder aus dem Don, noch dem Ural bekannt ist, und in der Wolga nur im Delta wohnt.

6. *Corophium curvispinum* Sars. Jaschan-See. 30. III. 19[illegible] (Kescher am Seeboden). 1 ♀ mit Eiern; ibidem, 13. VIII. 19[illegible] (Kescher im Ufergewächs). 19 ♂, 46 ♀, 14 juv., I. W. Starostin.

Die erbeuteten *Corophium* zeichnen sich durch ihre geringe Grösse aus: ♂ — [illegible] mm und ♀ — [illegible] mm. Eiertragende Weibchen [illegible]—12 Stück von einem Durchmesser von [illegible] mm) zeigen eine Länge von [illegible] mm. und wurden sowohl in den März- als auch in den Augustproben gefunden.

Die Anzahl der Geisselglieder der I. Antenne beträgt [illegible]. An den Epimeralplatten der I. Pereopoden befinden sich [illegible] lange befiederte Borsten und ca [illegible]—10 kleine Börstchen. Die Anzahl der Stacheln am Aussenrande der I. Uropoden ist relativ gross: am Basalglied 10—13 und am Aussenast 7—11. Am Distalende des Telson befinden sich 1—2 Stacheln und [illegible] Borsten. Am unteren distalen Ende des letzten Grundgliedes der II. Antenne befindet sich ein mehr oder weniger zugespitzter Vorsprung oder ein kleiner Zahn, ca [illegible] μ lang [cf. Behning ([illegible]) und Wundsch ([illegible]), *C. curvispinum devium*]. Dieser zahnartige Vorsprung ist bei *C. curvispinum* etwas viel kleiner und von einer etwas anderen Form, als bei der grösseren Art *C. robustum* Sars, wo seine Länge etwa 215—235 μ erreicht. Kleine zahnartige Vorsprünge kann man [illegible] auch bei kaspischen Exemplaren von *C. curvispinum* antreffen, wovon ich mich beim Durchmustern der Sars'schen Typen dieser Art im Zoologischen Museum der Akademie der Wissenschaften überzeugen konnte.

7. *[illegible]* Pallas. Jaschan-See. 13. VIII. 19[illegible] (Kescher im Ufergewächs), 1 juv., I. W. Starostin. Das gefundene Exemplar stellt ein [illegible] junges Tier von [illegible] mm Länge dar.

Das Auffinden der hier verzeichneten kaspischen Fauna im [illegible] See Jaschan ist natürlich von bedeutendem Interesse. [illegible] haben wir es hier mit Relikten [illegible] bis zu dieser Gegend, oder [illegible] zu deren grosser Nähe reichenden [illegible] Meeresbusen [illegible] den Grossen und Kleinen [illegible] des Kaspisees zu tun [cf. [illegible]schev ([8]), p. 207].

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d. [illegible] IX. [illegible]

## ZITIERTE LITERATUR

[1] [illegible] Behning, Zool. [illegible], 87 [illegible]. — [2] [illegible] — [3] [illegible] — [4] [illegible] — [5] [illegible] 25 [illegible] — [6] [illegible] 25 (1929). — [7] А. М. Никольский. Фауна России и сопредельных [illegible] — [8] [illegible] — [9] [illegible] — [10] [illegible] 19 [illegible] — [11] [illegible] — [12] [illegible] XXVI [illegible] — [13] [illegible] Wundsch, Zool. Anz. [illegible]

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*HYDROBIOLOGIE*

# ELEMENTE SUBTROPISCHER FAUNA AUF DEN REISFELDERN UZBEKISTANS (MITTELASIEN)

Von A. L. BEHNING

*(Vorgelegt von S. A. Zernov, Mitglied der Akademie, d. 13.IX.1938)*

In der aus zahlreichen Arten bestehenden Invertebraten-Wasserfauna, welche wir auf den Reisfeldern und den mit denselben zusammenhängenden Gewässern Mittelasiens vorfinden, kommen gemeinsam mit einer Anzahl üblicher paläarktischer Formen nicht selten Vertreter anderer Faunengebiete vor und zwar besonders solche, welche wir aus den tropischen und subtropischen Breiten und vor allem den Australischen, Orientalischen und Aethiopischen Regionen kennen.

In Bezug auf die Entomostraken der Reisfelder finden wir ähnliche Angaben in der neueren Literatur. So, bei Pashitnowa [5, 7]: *Latonopsis* sp., *Macrothrix* sp., und *Chydorus ad barroisi*—für die Reisfelder von Usbekistan, und bei Manfredi [3]: *Latonopsis orientalis* und *Macrothrix* sp.—für solche der Lombardei.

Während den, im Laufe des Jahres 1937, von der Universität in Samarkand systematisch ausgeführten Untersuchungen der umgebenden Reisfelder (Tschupan-ata, Gala-kapa, Dshambaj), wurde ein ausserordentlich interessanter Komplex derartiger Formen festgestellt.

**Ostracoda.** In der zahlreichen Ostrakodenausbeute aus diesen Stellen konnte Z. S. Bronstein folgende Arten verzeichnen: *Cypridopsis dentata marginata* Daday, *Cypretta dubiosa* (Daday), *Stenocypris malcolmsoni* (Brady), *Dolerocypris pellucida* Klie, *Dolerocypris sinensis* Sars, *Cypris subglobosa* Sowerby. Alle diese Arten sind hauptsächlich in den tropischen und subtropischen Breiten des den Indischen Ozean umgrenzenden Landteils verbreitet, wie in S. Amerika, Australien, Afrika, und kommen nur vereinzelnt in der Paläarktik vor, in welche sie nach Iran, Turkestan, zum Teil Kaukasus und bis Samara (*Dolerocypris sinensis*) vorgedrungen sind, oder aber aus den europäischen botanischen Gärten, als eingeschleppte Bewohner derselben (*Stenocypris malcolmsoni*), bekannt sind.

**Euphyllopoda.** Die auf den Reisfeldern öfters vorkommenden 2 Vertreter der *Conchostraca*, *Leptestheria* sp. und *Eulimnadia* n. sp. (det. S. S. Smirnov), sind ebenfalls ohne Zweifel subtropischer oder tropischer Herkunft. Nach den mir von S. S. Smirnov freundlichst mitgeteilten Angaben kommen die bisher bekannten 28 *Eulimnadia*-Arten fast ausschliesslich in tropischen und subtropischen Gebieten vor (hauptsächlich in Afrika, Australien und S. Amerika). In der Paläarktik wurden solche Arten bisher nur in N. Afrika, Japan, Transkaukasien und Turkestan aufgefunden.

**Cladocera.** Zwischen einer Anzahl von Kosmopoliten und weitverbreiteten Arten von Phyllopoden* konnte ich 6 unzweifelhaft südlicher (südöstlicher) Herkunft feststellen.

1. *Latonopsis australis* Sars. Reisfelder und diverse Kleingewässer der Umgebung von Samarkand (Tschupan-ata. Gala-kapa. Dshambaj). Juli-August. 1937. Dieselbe Art wird von Pashitnowa ([6], [7]) als *Latonopsis* sp. angeführt. Ein genauer Vergleich unserer Tiere mit der Beschreibung von Sars ([5]) und Birge ([1]) überzeugte mich, dass wir es hier mit dieser von Sars beschriebenen Art zu tun haben. Besonders charakteristisch für dieselbe sind die Gestalt der I. Antenne des ♂ und ♀, sowie das Postabdomen (Abb. 1).

Verbreitung: Australien, S. Amerika, Sunda-Inseln, Cochinchina, Hawaii-Inseln.

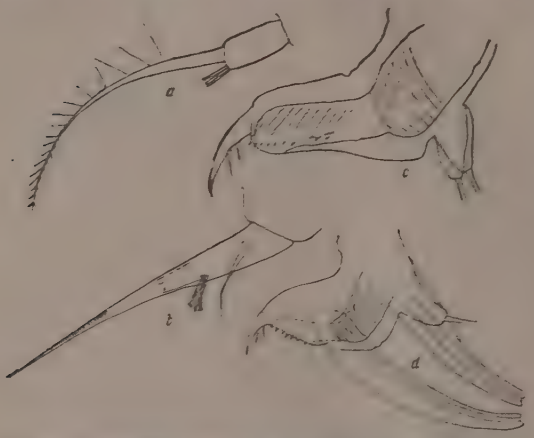


Abb. 1. *Latonopsis australis* Sars, Dshambaj, 3. VIII. 1937. *a*—I. Antenne ♀, *b*—I. Ant. ♂, *c*—Postabdomen ♀, *b*—dasselbe vom ♂; × 235.

Abb. 2. *Macrothrix odiosa* Gurney, Dshambaj, 3. VIII. 1937, ♀, Postabdomen; × 260.

2. *Macrothrix (Gurneyella) odiosa* Gurney (Syn.: *M. tenuicornis* Gurney. 1907). Reisfelder und diverse Kleingewässer der Umgebung von Samarkand—Dshambaj, Juli-August, 1937.

Diese relativ grosse Art der Gattung *Macrothrix* (♀ bis 1.00 mm) wurde meist gemeinsam mit *Latonopsis australis* gefunden; dieselbe Art wird ohne Zweifel von Pashitnowa ([6],[7]) als *Macrothrix* sp. angeführt. Die Zugehörigkeit zu dieser Art ersehe ich aus der relativ grossen Gestalt, dem völlig glatten Rückenteil der Schalen. dem deutlich ausgebildeten Kamm auf der vorderen Kopfseite [cf. *Echinisca capensis* Sars([8]) und die Abb. 22 bei Gurney ([4])], sowie der Gestalt und Bewaffnung des Postabdomens (Abb. 2), an welchem kleine dreieckige, allerdings nicht immer deutlich sichtbare Lappen («flaps», Gurney) an der mittleren Unterseite vorhanden sind. Diese Lappen veranlassen Brehm ([2]) solche Arten zu einer besonderen Gattung *(Gurneyella)* zu vereinigen.

Verbreitung: Indien, Sunda-Inseln.

3. *Macrothrix spinosa* (King?) Sars. Reisfelder von Dshambaj bei Samarkand. 3. VIII. 1937. Eine kleine Art (♀ mit Ephippium—420 μ), welche seltener als die vorhergehende angetroffen wurde, gewöhnlich gemeinsam mit derselben. Unsere Exemplare sind mit den Beschreibungen von Sars ([5]) und Brehm ([2]) identisch.

Verbreitung: Australien, Sunda-Inseln, S. Amerika, S. Afrika, Hawaii-Inseln.

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* Eine ausführliche Beschreibung der Cladocerenfauna dieses Gebietes erfolgt an anderer Stelle.

4. *Alona davidi* Richard. Reisfelder der Umgebung von Dshambaj bei Samarkand, 3. VIII. 1937. Sie wurde nicht selten auf einzelnen Reisfeldern im Herbst 1938 aufgefunden.

Für diese Art sind besonders charakteristisch (Abb. 3): breite typisch *Alona*-artige Schalen, zu einzelnen Büscheln vereinigte Borsten an der Seiten- und Hinter-Unterfläche des Postabdomens, ein kräftiger Stachel an der Basis und äusserst feine an der Seitenfläche der Endkrallen, sowie eine feine Reihe von winzigen Börstchen am äussersten unteren Hinterrande der Schalen. Die Weibchen haben eine Länge von 525—655 μ und Breite von 410 μ. Ebenfalls wurden Ephippien gefunden.

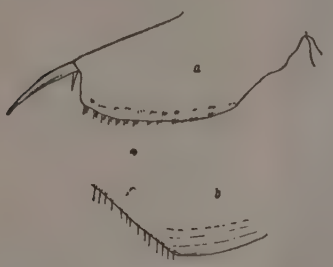

Abb. 3. *Alona davidi* Richard, Dshambaj, 3. VIII. 1937, ♀. *a*—Postabdomen, *b*—hinterer Unterrand der Schalen; × 260.

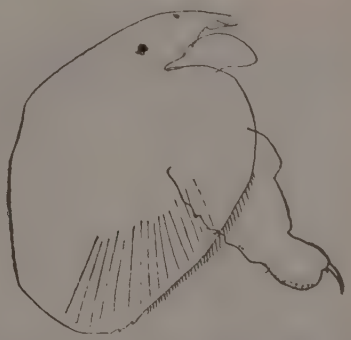

Abb. 4. *Alonella karua* (King), Dshambaj, 3. VIII. 1937, ♀, Seitenansicht; × 200.

Ich teile vollkommen die Ansicht von Stingelin ([10]), dass kein Grund zur Identifizierung dieser Art mit *Alonella diaphana* (King), wie das z. B. Sars ([8]) und Brehm ([2]) tun, vorliegt, jedenfalls nicht mit der Form, welche Sars unter diesem Namen beschreibt und abbildet. Dagegen ist *Alona punctata* Daday ([3]) unzweifelhaft mit unserer Art identisch.

Verbreitung: Australien, Sunda-Inseln, Ceylon, Afrika, S. Amerika.

5. *Alonella karua* (King). Reisfelder in der Umgebung von Dshambaj bei Samarkand, 3. VIII. 1937. Wurde im Laufe des August Monats auf einigen Reisfeldern in grösserer Anzahl angetroffen.

Das breite kurze Postabdomen (Abb. 4), seine Bewaffnung, die äusserst kleine Borste an der Endkrallenbasis, die 3 kleinen Zähnchen an dem unteren hinteren Schalenrande, sowie die nur spärlich entwickelte Strichelung der unteren hinteren Schalenflächen charakterisieren diese Art sehr gut. Die Länge der Weibchen beträgt 335—445 μ, Ephippien mit einem Ei wurden ebenfalls aufgefunden.

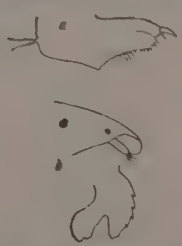

Abb. 5. *Chydorus barroisi* Richard, Dshambaj, 3. VIII. 1937, ♀. *a*—Postabdomen, *b* — Kopfspitze und Labrum; × 260.

Verbreitung: Australien, Sunda-Inseln, Indo-China, Afrika, N. und S. Amerika.

6. *Chydorus barroisi* Richard. Reisfelder in der Umgebung von Dshambaj bei Samarkand, 3. VIII. 1937.

Wurde nicht selten auf diversen Reisfeldern, sowie kleinen Gewässern in der Umgebung von Samarkand angetroffen. Es waren typische relativ kleine (Länge von eiertragenden Weibchen 265—320 μ) Tiere, welche durch die Bewehrung des Postabdomens und die gezähnte Lippe charakterisiert sind (Abb. 5).

Verbreitung: Sunda-Inseln, Ceylon, Afrika, SW-Asien, S. Amerika, Neuseeland, Transkaukasien.

Alle aufgezählten Arten gehören hauptsächlich zu den Bewohnern der tropischen und subtropischen Faunen und gelangten in unsere Gegenden und zwar auf die für sie am geeignetesten Stellen (Abb. 6) mit hohen Wassertemperaturen und reichem Pflanzenbewuchs, dank dem ihnen allen gemeinsamen Vorhandensein von äusserst resistenten Eiern. Die Ephippien der Cladoceren benötigen im allgemeinen, wie bekannt, zur Entwicklung des Einfrierens oder des Austrocknens; bei einer Anzahl von Ostrakodenarten ist bekannt, dass die Eier, oder ebenso die Larven und Erwachsenen das Austrocknen überstehen und sogar noch aus völlig trockenen Schlammproben sich entwickeln; ebenso vertragen die Conchostrakeneier Austrocknen.

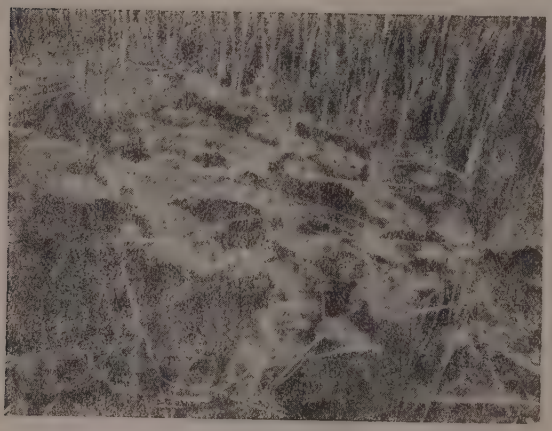

Abb. 6. Freie Wasserfläche eines Reisfeldes (Tschupan-ata) mit Algenüberzug, 16. VII. 1937.

In Bezug auf die Art und Weise, wie nun diese Formen in unsere Gegenden vorgedrungen sind, scheint es mir, dass die Haupt-, wenn nicht die ausschliessliche Rolle den Zugvögeln zukommt. Wir wissen allerdings noch sehr wenig über die Zugstrassen der in Indien und überhaupt Südostasien überwinternden Vögel, indessen treffen wir bei uns in Uzbekistan eine Anzahl von in Indien und anderen südlicheren Gegenden überwinternden Vögeln. Hier kann man, wie mir freundlichst von A. I. Iwanov mitgeteilt wurde, z. B. nennen: *Ciconia ciconia*, *C. nigra*, *Grus grus*, *Anas platyrhyncha*, *Dafila acuta*, *Spatula clypeata*, *Marmoretta angustirostris*, *Netta rufina*. Diese Vögel können nun ohne Zweifel im Laufe der Zeit * als passive Verschlepper dieser Dauerstadien diverser Wassertiere in Betracht kommen, indem sie zeitweilig (die Enten), oder aber auch ständig (Störche, Kranich) sich auf den Reisfeldern aufhalten.

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## ZITIERTE LITERATUR

[1] E. Birge, Trans. Wisc. Acad., 4 (1891). [2] V. Brehm, Arch. f. Hydrobiologie, Suppl. XI, 4 (1933). [3] E. Daday, Termesz. Füzet., XXI (1898). [4] R. Gurney, Rec. Ind. Mus., I, 1 (1907). [5] P. Manfredi, Atti Soc. Ital. Milano, LXXI, II (1932). [6] З. А. Пажитнова, Тр. Ср.-Аз. гос. ун-та, VIIIa, 10 (1929). [7] З. А. Пажитнова, ibid., VIIIa, 18 (1935). [8] G. O. Sars, Vid. Selsk. Forh. Christiania, 7 (1888). [9] G. O. Sars, Ann. S. Afr. Mus., XV (1916). [10] Th. Stingelin, Zool. Jahrb. Syst., XXI, 3 (1904).

* Nach den Angaben von Gustshin (1930) soll Alexander der Grosse (IV Jahrb. v. unserer Zeitrechnung) in Turkestan schon die Reiskultur angetroffen haben.

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*GENETICS*

# INTRAVARIETAL CROSSING IN PEAS*

By T. K. ENIN

*(Communicated by N. I. Vavilov, Member of the Academy, 27.VIII.1938)*

The Technique of the Experiment. As a material for the work served selected varieties of vegetable peas known under the names «Albanian» (G-6), «For Canning» (G-168) and «Sugary green-seeded» (G-179a). Crossing within varieties was performed in 1935 in the fields where elite was propagated. In selecting pollen-parents we followed the method of Lyssenko, Member of the Academy, who recommends the application of mixture of pollen (1).

All the seeds were planted in 1936 in the field in order to obtain $F_1$. Sowing was conducted by the one-row method in families, the nutrition area being $70 \times 10$ cm; the single family was composed of seeds taken from one pod. The number of $F_1$ families, which in the following are termed «crosses», was approximately equal to the number of the control families; the latter alternated with the experimental ones.

Following harvest the $F_1$ plants were investigated in the laboratory in order to determine the weight of seeds per plant, the number of pods per plant and the number of seeds per pod.

Simultaneously with the intravarietal crossing pure lines were started in the varieties G-6 and G-179a in order to check the constancy of these varieties with regard to the characters studied.

According to data of phenological observation the percentage of germination was lower in the crosses which was due to smaller size of the seeds. In flowering and ripening the plants from crosses showed no strong differences from the control. All the plants from the cross-families and from the control were uniform with regard to qualitative characters. Among the pure line progenitors in the variety G-6 plants possessing blunt-pointed pod, not characteristic of the variety, were noted.

Below is Table 1, showing the number of seeds sown, the number of $F_1$ plants harvested arranged in families.

The data of the analysis of plants with regard to the characters mentioned above were subjected to biometrical treatment. For the weight of seeds per plant was taken the weight of seeds per family divided by the number of plants in the family. The number of pods per plant as well as the number of seeds per pod were determined in an analogous way. The biometrical constants relating to the three characters mentioned are placed in Tables 2, 3 and 4.

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* Such a cross is known under the name of «isomorphic xenogamy» (2).

Table 1

| Varieties | Number of families started | | Number of families harvested | | Percentage of families survived | | Number of seeds planted | | Number of plants harvested | | Percentage of plants survived | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cr. | Con. | Cr. | Con. | Cr. | Con. | Cr. | Con. | Cr. | Con. | Cr. | Con. |
| G-179a «Sugary green-seeded» | 60 | 60 | 48 | 55 | 80.0 | 91.6 | 269 | 344 | 160 | 233 | 60.7 | 61.6 |
| G-168 | 123 | 122 | 122 | 119 | 91.0 | 89.3 | 759 | 948 | 633 | 815 | 83.4 | 85.9 |
| G-6 «Albanian» | 7 | 46 | 42 | 43 | 83.9 | 93.4 | 262 | 294 | 152 | 226 | 58.0 | 75.8 |

Table 2

G-179a, «Sugary green-seeded»

| Designation adopted | Weight of seeds per plant in g | | Number of pods per plant | | Number of seeds per pod | |
|---|---|---|---|---|---|---|
| | Cross | Control | Cross | Control | Cross | Control |
| $n$ (number of families) | 48 | 55 | 48 | 55 | 48 | 55 |
| $M$ (arithmetical mean) | 2.0154 | 1.841 | 3.130 | 2.739 | 3.839 | 3.824 |
| $\sigma$ (square deviation) | 0.731 | 0.853 | 0.788 | 0.977 | 0.833 | 0.686 |
| $m$ (square error) | 0.105 | 0.115 | 0.113 | 0.132 | 0.120 | 0.192 |
| $t$ | 1.11<3 | — | 1.25<3 | — | 0.151<3 | — |

Table 3

G-168, «For Canning»

| Designation adopted | Weight of seeds per plant in g | | Number of pods per plant | | Number of seeds per pod | |
|---|---|---|---|---|---|---|
| | Cross | Control | Cross | Control | Cross | Control |
| $n$ (number of families) | 122 | 119 | 122 | 119 | 122 | 119 |
| $M$ (arithmetical mean) | 993 | 2.554 | 3.044 | 2.706 | 5.865 | 5.50 |
| $\sigma$ (square deviation) | 1.111 | 0.837 | 0.874 | 0.727 | 0.964 | 1.11 |
| $m$ (square error) | 0.101 | 0.176 | 0.081 | 0.66 | 0.087 | 0.101 |
| $t$ | 3.1>3 | — | 3.18>3 | — | 2.75<3 | — |

Measurements and statistical treatment of the pure lines were based on 10 plants of each line. All the data are placed in table 6.

The Results of the Experiment upon Biometrical Treatment of $F_1$. For $n=48$ and $n=55$, $t$ should not be less than 3 in all characters. As a matter of fact, we have $t=1.11$ for the weight of seeds per plant, $t=1.25$ for the number of pods per plant and $t=0.152$ for the number of seeds per pod. The significance of differences, therefore, is not mathematically proved in all the characters analyzed.

From Table 3 it is evident that the meaning of $t$ for two characters fully supports the significance of the means (more than three) in favour of the intravarietal crossing. With regard to the number of seeds per pod the difference is mathematically insignificant.

In Table 4 $t<3$ with regard to all the characters, and the differences of the means should, therefore, be considered mathematically insignificant.

Table 4

G-6, «Albanian»

| Designation adopted | Weight of seeds per plant in g | | Number of pods per plant | | Number of seeds per pod | |
|---|---|---|---|---|---|---|
| | Cross | Control | Cross | Control | Cross | Control |
| $n$ (number of families) . . | 42 | 43 | 42 | 43 | 42 | 43 |
| $M$ (arithmetical mean) . . | 4.166 | 3.471 | 3.86 | 2.638 | 4.303 | 4.301 |
| $\sigma$ (square deviation) . . . . | 2.291 | 1.138 | 1.186 | 0.997 | 0.993 | 1.250 |
| $m$ (square error) . . . . . | 0.353 | 0.173 | 0.182 | 0.152 | 0.154 | 0.194 |
| $t$ . . . . . | 1.8<3 | — | 1.86<3 | — | 0.008<3 | — |

As a result of the biometrical treatment of the $F_1$ from crossing and of the control in three varieties of peas, it is concluded that the difference in the number of seeds per pod was insignificant in all cases. The difference was significant for the number of pods and for the weight of seeds per plant in favour of the intravarietal crossing only in case of G-168. In other varieties the difference of means for these characters was also insignificant.

Table 5

| Designation adopted | Number of pods per plant | | Weight of seeds per plant | | Note |
|---|---|---|---|---|---|
| | 1st ser. | 2nd ser. | 1st ser. | 2nd ser. | |
| G-6, «Albanian» (pure lines) | | | | | |
| $n$ (number of lines) . . . | 59 | 59 | 59 | 59 | For each measurement were taken 10 plants from each line |
| $M$ (arithmetical mean) . . | 2.957 | 2.745 | 3.663 | 3.596 | |
| $\sigma$ (square deviation) . . . | 0.968 | 0.682 | 0.924 | 0.648 | |
| $m$ (square error) . . . . . | 0.126 | 0.089 | 0.120 | 0.084 | |
| $t$ . . . . . | 1.6<3 | — | 0.5<3 | — | |
| G-179a, «Sugary green-seeded» (pure lines) | | | | | |
| $n$ (number of lines) . . . | 77 | 77 | 77 | 77 | For measurements were taken 10 plants from each line |
| $M$ (arithmetical mean) . . | 3.571 | 3.350 | 2.658 | 2.532 | |
| $\sigma$ (square deviation) . . . | 0.89 | 0.713 | 0.844 | 0.947 | |
| $m$ (square error) . . . . . | 0.101 | 0.081 | 0.095 | 0.108 | |
| $t$ . . . . . | 1.7<3 | — | 0.11<3 | — | |

It may be observed from comparison of the biometrical constants of the pure lines with those calculated for the cross and the control in varieties G-6 and G-179a that in the former (G-6) these values appear to be significantly greater in the cross, than in the control or in the pure lines. In the latter variety (G-179a) they appeared, on the contrary, to be smaller in case of the cross, than in the control or in the pure lines (Tables 2, 4, 5).

The value of sigma indicates different variability of the characters in varieties G-6 and G-179a in case of the cross. The variety G-6 was evidently heterogeneous with regard to the characters in question. The variety G-179a was comparatively uniform.

The Results of the Experiment upon Biometrical Treatment of $F_2$. Seeds from plants of the $F_1$ families from crossing and from control in the three varieties were sown separately at

a field-lot with a nutrition area 10×15 cm. As in $F_1$, the $F_2$ families from crossing alternated with the control; this served to a considerable extent as compensation for the absence of the generally accepted repetitions.

Harvesting and measurements of the plants were made in the same conditions and the same characters were considered as in case of $F_1$; the method was also identical. For the biometrical treatment were taken 26 well preserved families of each variety.

The results of the biometrical treatment of the means are given in Table 6.

Table 6

| Designation adopted | Weight of seeds per plant | | Number of pods per plant | | Number of seeds per pod | |
|---|---|---|---|---|---|---|
| | Cross | Control | Cross | Control | Cross | Control |
| G-179a, «Sugary green-seeded» | | | | | | |
| $n$ (number of lines) | 26 | 26 | 26 | 26 | 26 | 26 |
| $M$ (arithmetical mean) | 1.632 | 1.362 | 2.519 | 2.265 | 1.861 | 1.910 |
| $\sigma$ (square deviation) | 8.565 | 0.440 | 0.568 | 0.511 | 0.618 | 0.478 |
| $m$ (square error) | 0.11 | 0.090 | 0.115 | 0.10 | 0.121 | 0.093 |
| $t$ | 1.9<3 | — | 1.7<3 | — | — | 0.152<3 |
| G-168, «For Canning» | | | | | | |
| $n$ (number of lines) | 26 | 26 | 26 | 26 | 26 | 26 |
| $M$ (arithmetical mean) | 1.452 | 1.292 | 1.785 | 1.677 | 3.143 | 3.150 |
| $\sigma$ (square deviation) | 0.416 | 0.417 | 0.262 | 0.216 | 0.672 | 0.569 |
| $m$ (square error) | 0.06 | 0.09 | 0.052 | 0.042 | 0.132 | 0.120 |
| $t$ | 1.3<3 | — | 1.7<3 | — | — | 0.09<3 |
| G-6, «Albanian» | | | | | | |
| $n$ (number of lines) | 26 | 26 | 26 | 26 | 26 | 26 |
| $M$ (arithmetical mean) | 2.019 | 2.008 | 2.011 | 2.035 | 1.773 | 1.742 |
| $\sigma$ (square deviation) | 0.487 | 0.512 | 0.296 | 0.246 | 0.630 | 0.426 |
| $m$ (square error) | 0.096 | 0.105 | 0.058 | 0.048 | 0.123 | 0.084 |
| $t$ | 0.6<3 | — | — | 0.30<3 | 0.90<3 | — |

It may be seen from Table 6 that in all varieties and for all the characters analyzed $t$ indicates insignificance of the difference between the means in favour of the cross or of the control (less than three). These results remind of those in $F_1$ for two varieties (G-6 and G-179a). As to the third variety (G-168), the significance of the difference in the number of pods and the weight of seeds per plant in favour of the intravarietal cross, which was found in $F_1$, failed to be detected in $F_2$; this makes the results obtained in $F_1$ uncertain.

## Conclusions

An analysis of $F_1$ and $F_2$ from intravarietal crossing, control (of the maternal line) and of pure lines in two varieties of peas gave the following results:

1. An increase in the number of pods and in the weight of seeds per plant as compared with the control in favour of intravarietal cross was observed. Such a positive effect was mathematically significant only in $F_1$ for the variety G-168. For the varieties G-6 and G-179a in the two generations, as well as for the variety G-168 in the second generation, such an effect of the intravarietal crossing appeared to be insignificant.

2. Conflicting results were obtained in all the varieties in $F_1$ and $F_2$ for the number of seeds per pod. An insignificant difference in favour of the cross in this character was observed, while in $F_2$ a similarly insignificant difference in favour of the control was found.

3. The results of the analysis of the pure lines started in the varieties G-6 and G-179a indicate a comparative homogeneity of the variety G-179a and a heterogeneity of the variety G-6 with regard to the characters in question.

4. The results of our experiment with peas, as well as literary data on crossing within varieties in peas ([2],[3]), enable one to the assertion that intravarietal crossing produced no positive effect in the varieties employed with ragard to the characters analyzed. In one of the varieties such an effect was obtained in $F_1$, but it was not confirmed in $F_2$ which represents evidence against intravarietal crossing. All the above said becomes intelligible in the light of explanations given by Darwin himself ([2]); following Darwin, an effect may be obtained from intravarietal crossing in peas when parental forms are cultivated under different conditions during a long period of time prior to crossing. No such conditions were created in our case.

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REFERENCES

[1] Лысенко, Яровизация, № 1 (1935). [2] Ch. Darwin, The effects of cross and self-fertilization in the vegetable kingdom (1876). [3] E. Tschermak, Ber. d. D. Bot. Ges., XVIII (1900).

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*GENETICS*

# ON THE PHENOTYPICAL MODIFICATION OF SEXUAL CHARACTERS IN HIGHER PLANTS UNDER THE INFLUENCE OF THE CONDITIONS OF NUTRITION AND OTHER EXTERNAL FACTORS

By E. G. MININA

*(Communicated by D. N. Prianishnikov, Member of the Academy, 13.IX.1938)*

The idea as to the decisive rôle of the surrounding conditions in the sexualization of organisms found an important verification in the recent physico-chemical theory by Joyet-Lavergne (1). This theory is based upon the processes depending on the physico-chemical properties of the cytoplasm. The manifestation of the sexual characters is noted in cytoplasm earlier than in the nucleus; therefore, the author terms sexualization cytoplasmic. The presence of sex-chromosomes in organisms, in the author's opinion, is an expression of a certain physiological condition of the cell being an important but secondary character of sexualization.

In certain works of a series of investigators a convincing material is presented which proves the phenotypical nature of sexualization. In single cases it has proved possible to cause in some plants even full sex-reversal by means of photoperiodic or surgical influences.

The object of our investigation was to raise the yielding capacity of crops by means of external factors acting upon the sexualization of the organisms. As previously shown, we succeeded in showing that it is possible to create by a suitable regimen of mineral nutrition conditions, favourable for the development of the one or the other sex (2). Experiments with corn enabled us to the following conclusions:

1. Mineral nutrition appears to be a mighty factor of form-diversity and of sexualization.

2. In case of periodic nitrogen nutrition female sexualization of plants occurs.

3. In case of periodic potassium nutrition, on the contrary, male sexualization takes place.

4. An increase in sugar content and a decrease in the amount of total nitrogen as compared with masculinized plants could be detected in feminized plants.

It was important to prove in subsequent investigations that similar influence is possible: 1) in plants of other families, 2) by other components of mineral nutrition and 3) by other external factors.

Experiments were conducted in vegetative vessels at field-plots and in greenhouses. As experimental plants were tried *Cucumis sativus*, *Cucumis melo* and *Zea mays*.

I. The Influence of the Periodic Nitrogen and Potassium Nutrition. Three most typical versions of the experiments are presented in Table 1: 1) control—introduction of the full dosage of NPK by means of mixing up together with all the soil while filling vegetative vessels; 2) periodic nitrogen nutrition—PK $^1/_3$ N is introduced while filling vegetative vessels by means of mixing up with the soil, plus $^1/_3$ N before formation of flower buds, plus $^1/_3$ N at the time of flowering (dissolved in water used for watering of plants); 3) periodic potassium nutrition—PN $^1/_3$ K introduced as before when filling vegetative vessels, plus $^1/_3$ K before formation of flower buds, plus $^1/_3$ K during flowering together with the water used for watering plants.

Table 1

Changes in Biochemistry and in Number of Flowers of Different Sex in Cucumber plants (*Cucumis s.*)

| | | Control | Periodic nitrogen nutrition | Periodic potassium nutrition |
|---|---|---|---|---|
| Shoots of the 1st order | Sugar amount in % | 4.09 | 8.82 | 3.96 |
| | Total N | 2.57 | 2.04 | 3.09 |
| | Sugar/total N | 1.54 | 4.32 | 1.27 |
| Shoots of the 2nd order | Sugar amount in % | 4.00 | 8.77 | 3.93 |
| | Total N | 3.58 | 2.33 | 3.08 |
| | Sugar/total N | 1.16 | 3.80 | 1.28 |
| Number of flowers of shoots of the 1st order | ♂ | 58.5 | 39.3 | 51.5 |
| | ♀ | 4.1 | 5.6 | 3.5 |
| | ♀/♂ | 0.07 | 0.14 | 0.06 |
| Number of flowers of shoots of the 2nd order | ♂ | 15.8 | 7.6 | 21.1 |
| | ♀ | 4.0 | 7.3 | 4.6 |
| | ♀/♂ | 0.25 | 0.96 | 0.20 |

In case of periodic nitrogen nutrition the sugar content increases twice, while total nitrogen content somewhat drops; the ratio $\frac{\text{sugar}}{\text{total N}}$ is, therefore, greatly altered.

Table 2

Yield of Fruits in *Cucumis sativus* in g

| Variants | Experiment in vegetative vessels | | | Experiment in field |
|---|---|---|---|---|
| | Dry weight of the green mass | Weight of fruits | Number of fruits | Weight of fruits in g |
| Control | 8.32 | 667.9 | 10 | 514 |
| Periodic nitrogen nutrition | 17.28 | 204.8 | 20 | 1274 |
| Periodic potassium nutrition | 11.92 | 451.0 | 5 | — |

Increased female sexualization leads in *Cucurbitaceae* to an increase in yield. Increased male sexualization leads to a drop in yield. Similar results were obtained on melons under field conditions; they are not described here for lack of space.

The experiment thus enables one to the following conclusions: the *Cucurbitaceae*, similar to corn, change the direction of the development of sex in connexion with the conditions of mineral nutrition.

II. Influence of Sulphate Starvation. The experiment was conducted on corn grown in sand following Nightingal's scheme ([3]).

Table 3

| Variants | Growing parts of plants | Dry weight of plants | Content in % | | | Number of male flowers | Number of female flowers | ♀/♂ |
|---|---|---|---|---|---|---|---|---|
| | | | Sugar | Total N | Sugar / total N | | | |
| Sulphur starvation . . . . . | lower | 16.33 | 17.55 | 1.28 | 13.7 | 1.0 | 3.5 | 3.5 |
| | upper | 5.73 | 6.68 | 1.09 | 6.1 | | | |
| Control . . . . . | lower | 17.46 | 12.10 | 1.74 | 6.9 | 1.5 | 2.5 | 1.7 |
| | upper | 8.11 | 2.63 | 1.22 | 2.2 | | | |

Accumulation of sugar in plants lacking sufficient amount of sulphur is probably due to the delay of the synthesis of proteins and leads to a preponderance of the female sexualization.

III. Influence of Carbon Oxide. The experiment was arranged at the Klin vegetable crop station of the Timiriasev Agricultural Academy and conducted on cucumbers in a greenhouse. The action of gases was attained by the Klin method which requires a special heating (the method received its name from the town Klin where it was worked out by practical gardeners). The technique is as follows: after the wood is lightened, the stoves are hermetically closed, the flaws are plastered so that the wood smoulders and produces carbon oxide which penetrates through the pores of the bricks into the greenhouse. The analysis has shown that 0.03% of carbon oxide is contained in the gases so produced. Plants which had developed 3—4 leaves greatly change externally after two treatments by this atmosphere during 11—12 hours each; the leaves sink and become pale and fragile. The influence of carbon oxide upon the fermentative processes in plants was previously established by American investigators ([4]). In the given case we succeeded in noticing the strong influence of this gas upon sexualization.

Table 4

Type of Sexualization in *Cucumis sativus*

| Plants | ♀/♂ after 16 days | ♀/♂ after 30 days | Weight of fruits in g |
|---|---|---|---|
| Controls . . . . . | 0.04 | 0.08 | — |
| Experiments . . . . . | 0.46 | 0.23 | 529 |

The experimental plants gave normal yield of fruits, while those which were not subjected to the gas treatment did not set fruits at all. The ratio ♀/♂ is ten times greater in experimental plants than in control.

The observations have shown that female flowers appeared first on plants which had undergone gas treatment, and male flowers were rare. With further development of the plants the number of male flowers increased. No decrease in development of female flowers could be noticed, however, till the end of the experiment (35 days after treatment).

The value of the ratio $\frac{\text{♀ flowers}}{\text{♂ flowers}}$ alters as time passes from the moment of treatment. After having attained a definite maximum this value drops.

According to the results of certain workers ([4,5]), carbon oxide is presumed to influence the activity of oxidizing ferments and cause important changes in the metabolism. Alongside of the disturbance of acid-alkaline equilibrium in animal tissues, there was observed an increase in reducing sugar ([6]).

The data received by us in the last experiments with cucumbers corroborate with full clarity the assumptions on the influence of carbon oxide upon the trend of the inner organic processes. The change in the direction of increment of sugar in the tissues should have naturally manifested itself in a noticeable predominance of the female sexualization which was actually revealed by the experiment.

It should be concluded from the foregoing experimental data that an increased sugar content is in all cases connected with the preponderance of the development of the female sex. The existence of such a direct connexion between the type of sexualization and the sugar content makes one suppose a corresponding shift in the redox conditions of the tissues. It is possible that the increase in the amount of the reducing sugar leads to a decrease in rH, i. e. to the preponderance of reduction processes which cause sexualization of tissues in the direction of femaleness. On the contrary, reduction of the amount of reducing sugar causes an increase in rH and gives the organisms the male sign.

Following Joyet-Lavergne's theory of cytoplasmic sexualization, we think that the question on whether the decisive rôle is played here directly by the value of the oxidizing-reducing potential itself, or some materials are formed under the conditions of a certain rH value which sexualize the tissues in a certain direction, should be considered open.

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13. IX. 1938.

REFERENCES

[1] Joyet-Lavergne, La Physico-Chimie de la Sexualité, Monographie Protoplasma (1935). [2] Минина и Гусева, Химиз. соц. земледел., № 3 (1937). [3] Nightingal, Schermerhorn a. Rolins, Plant Physiol., 7, № 4 (1933). [4] Haldane, Biochem. Jrnl., XXI, № 5 (1927). [5] Keilin, Nature, 119, 67 (1927). [6] Черкес и Мельникова, Тр. и мат. Укр. гос. ин-та патол. и гиг., вып. 6 (1928).

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*PLANT PHYSIOLOGY*

# COLCHICINE-INDUCED TETRAPLOIDY IN FLAX

By V. A. RYBIN

(Communicated to the U. S. S. R. Academy of Sciences, 9 X 1937)

Among the plants of various families used for experiments on producing polyploidy by Blakeslee's method [1] several specimens of flax were included. In the present paper we describe in more detail the experiment with one of the latter specimens, an Argentine seed flax (Cat. No 4166, Department of Flax and Hemp, Institute of Plant Industry), since the experiment with this specimen has been completed and has given positive results*. As the method of producing polyploid forms by colchicine treatment will, undoubtedly, play an important rôle in general and plant-breeding work, and as published data on the optimum conditions for obtaining the desired effect of chromosome doubling in various plants are comparatively meagre, we believe that a detailed description of the experiment should be of interest.

A small quantity (0.1 g) of colchicine** was dissolved immediately before the experiment in 100 cm³ of distilled water at room temperature. The colchicine dissolved readily, making a solution pale yellow in colour and with a faintly perceptible, ether-like odour. A pot with six plants, 8 cm in height and having 15 or 16 true leaves besides the cotyledons, had been well watered the evening before, after which the surface of the soil was covered with cotton wool and then with parchment, in which six openings had been cut out for the plants and the edges of which were securely fastened down by a string around the rim of the pot. The tips of the upper leaves of three out of six plants in the pot were cut off***, after which the pot was turned upside down and set on a wooden stand. The four plants with cut leaves were immersed at once in test-tubes containing a 0.1% solution of colchicine. The test-tubes were sunk for three-quarters of their depth in a pot filled with sand, which served as a support for the test-tubes. Thus, the plants immersed in the colchicine solution were screened from direct light. The experiment was carried out in a glass case in the greenhouse, at a temperature of 16—19° C. which increased, however, at those times when the sun came out from behind the clouds, to 27° C.

The plants were kept in the colchicine solution for a period of 23½ hours. At the time of the removal of the plants from the colchicine solution the tips of the control plants were turned upward, having made during the 23-hour

* This specimen was obtained from P. S. Kuznetsova of the Department of Geographical Investigation of the Institute of Plant Industry, to whom I wish to express my sincere gratitude.

** Prof. S. P. Tregubov, of the Chemico-Pharmaceutical Institute, kindly supplied the colchicine used in the experiment.

*** The leaves were cut in order to study the action of the colchicine on the plant, a procedure suggested in Blakeslee's paper [1].

period a geotropical flexure of 180°. The plants immersed in the colchicine were prevented from making such a flexure by the test-tubes, which were comparatively small in diameter*.

Upon removing the plants from the colchicine, the only noticeable change was a slight yellow discoloration of the upper leaves. During the next few days, however, the treated plants began perceptibly to lag behind in growth, as compared with the control plants, and after ten days they acquired a very characteristic habit. The cotyledons turned brown, and became dry and shrivelled along the edges. The stems, of normal thickness at the surface of the soil and in their lower half, exhibited in their upper half a peculiar swelling, gradually increasing toward the tip (Fig. 1)**. The swollen tips ended in a rosette-like cluster of leaves. Looking down from above with a magnifying glass on such a rosette, it could readily be seen that it was open and consisted of a large number of leaves, which, uniformly decreasing in size, were regularly arranged around the point of growth. The portion of the stem just below the rosette, besides being swollen, was characterized by a shortening of the internodes, by a certain irregularity of the leaves, and by their horizontal position. In the case of the control plants, the leaves on the upper part of the stem stood out at an acute angle to the latter, as is characteristic, in general, of normal flax plants.

Fig. 1. Flax seedlings: the tops of the two at the left had been immersed in a 0.1% colchicine solution; right, control plant. Stems of treated plants show characteristic thickening toward the top, and have shortened internodes

As time went on, the shoots altered by the colchicine treatment became more and more retarded in development, and after 40 days from the beginning of the experiment the main stems with the yellowed apical rosettes, having by then entirely ceased to grow, were overtopped by the side shoots arising from the axils of the cotyledons (Figs. 2 and 3). The shoots on the treated plants were clearly of two types: some normal with smooth, somewhat glossy leaves of regular shape and forming an acute angle with the stem (Fig. 3); others, of the second type, clearly abnormal in structure (Fig. 2). Especially striking was their darker colour and the greater predominance of a bluish hue. The leaves were not glossy but mat. The leaf blades were not perfectly regular in shape and had undulating edges, and they were often deformed or not fully developed. Of the four treated plants one had two abnormal shoots, one—two normal, one—two slightly altered and one—one abnormal and one normal.

From the external appearance of the altered shoots it might be presumed that they were either chimeral, or possessed doubled or quadrupled chromosome number. Subsequently, the distinguishing characteristics of the

* I have drawn attention to the geotropical bending of the plants during the time of the colchicine treatment, because it shows that the plants during the experiment were making active growth, which is essential for obtaining the required results from colchicine treatment.

** In the figure is shown a different specimen of flax, i. e. Egyptian. No 265, at the same stage.

altered shoots became considerably less noticeable, and the plants acquired almost a normal appearance. The main stems at the time of flowering and seed-bearing had completely died away.

Prior to the appearance of flower buds in the altered shoot* of plant No 1163/3, pictured in Fig. 2, several leaves were taken from the midportion of the stem for anatomical analysis. A cross-section of the leaf blade showed

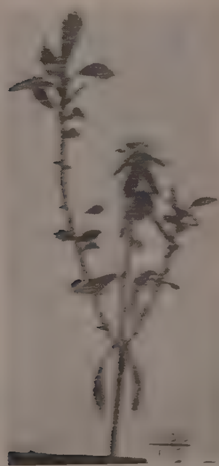

Fig. 2. Colchicine-treated flax plant No 1163/3. Main stem has ceased development; from axils of the cotyledons two altered shoots are growing

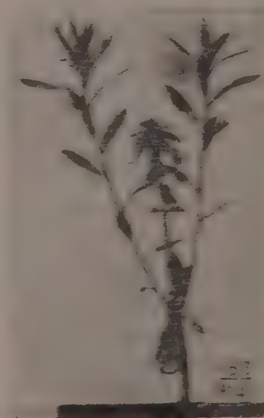

Fig. 3. Colchicine-treated flax plant No 1163/4. Main stem has ceased development; from axils of the cotyledons two unaltered, normal shoots are growing

its greater thickness, as well as the larger size of the parenchyma cells composing it, as compared with similar leaves taken from the same height on the stem of a normal plant in the same pot. An examination of the epidermis taken from a leaf revealed a perceptible difference in the size of the guard cells of the stomata**; the latter were considerably larger in leaves from the altered shoot of plant No 1163/3, as compared with the control. The larger size of the anatomical elements, as well as the absence on the shoot of plant No 1163/3 of any marked irregularities in development or of any deformities, led us to believe that we had to do with a tetraploid shoot, which had arisen as the result of chromosome doubling induced by the colchicine treatment. This assumption was, subsequently, fully confirmed. All buds and flowers of plant No 1163/3 were considerably larger than those of the control plant in the same pot (Fig. 4: above—flower of control plant; below—of plant No 1163/3). An examination of the pollen showed that in plant No 1163/3 the pollen grains were twice as large as those of the control plant (Fig. 5—pollen of the control plant, Fig. 6—of plant No 1163/3). The flowers of plant No 1163/3 were examined one after another as they opened. They were all characterized by large pollen. However, the number of seeds

* The other altered shoot of this plant had ceased development and died.

** In examining the anatomical elements of the leaves and also in examining the pollen, I used a Leitz comparison microscope, which makes it possible, without preliminary measurements, to compare the relative size of the pollen grains or other anatomical elements of two plants, without need of using an ocular- and objective-micrometer. This greatly accelerated the work.

ed in plant No 1163.3 was less than in the control. Of three mature capsules [illegible] which were left to complete ripening one contained 2, one 1, and one [illegible] seeds. One of the flowers did not produce any capsules. The seeds, as well as the capsules, of plant No 1163.3 considerably exceeded in size the seeds and capsules of the control plant, No 1163.5 (Fig. 3). From five seeds, taken from two capsules and sown July [illegible], five seedlings were obtained. One of them came up twisted, and had a thickened hypocotyl which turned green in the light; it soon died, without unfolding its cotyledons. The chromosome number of this seedling is not known, since in its root-tip which we fixed we did not succeed in finding a nucleus in process of division;

Fig. 2. Below—flower from tetraploid shoot of treated plant No 1163.3; above—flower from control plant No 1163.5. Nat. size.

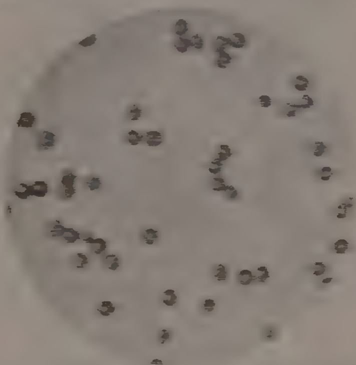

Fig. 3. Pollen from treated plant [illegible]. Ocular 7 ×, obj. [illegible].

[illegible] the cells had vacuoles and their nuclei were in the resting stage. The other four seedlings developed normally, and by examining their root-tips it was found that all four had the tetraploid chromosome number [illegible].* The material was fixed with a [illegible] solution of chromium-acetic [illegible] and stained with iron-haematoxylin.

The other colchicine-treated plants in the original pot also blossomed and set capsules, but their seeds have not been sown, and so the genotypical nature of the changes produced has not yet been determined. However, an examination of the pollen in flowers of altered shoots revealed in all cases large pollen grains, approximately twice as large as normal. In some flowers there were, moreover, pollen grains three or four times as large as normal. Sometimes the pollen consisted of a mixture of large and normal grains.

Another form of flax [illegible] No [illegible], reacted in exactly the same way to immersion in a colchicine solution, also producing altered shoots, flowers with large pollen grains, and large capsules.

Early in June I tested the above-described method of producing flax tetraploids on a considerably larger number of plants, taking for the experiments two additional forms of flax [illegible] No [illegible] and [illegible] No [illegible]. The results obtained with the [illegible] flax No [illegible] were fully confirmed: after immersion for one day in a [illegible] solution of colchicine, the plants [illegible] show the characteristic morphological changes of the main stem. Most of the colchicine plants [illegible] in the axils of the coty-

* According to [illegible], the normal chromosome number of Linum usitatissimum is [illegible].

ledons are morphologically altered and produce flowers with large and, to all appearances, polyploid pollen. Often these flowers are slightly irregular in shape with crumpled petals. Occasionally there were flowers with more than the normal number of petals. The large (polyploid) pollen grains formed in flowers of colchicine-altered shoots germinate well when provided with the conditions necessary for their germination*. The complete analogy between the changes induced by colchicine in plants of the Argentine flax No 1163 and those induced in the forms Cyprus No 2082, Azerbaidjan

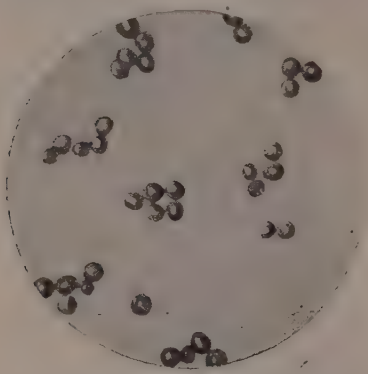

Fig. 6. Pollen from tetraploid shoot of treated plant No 1163/3. Ocular 5 ×; obj. 8 × (Zeiss).

Fig. 7. Capsules and seeds: left—of control plant No 1163/5; right—of tetraploid shoot of treated plant No 1163/3. Nat. size

No 5252, and Egyptian No 265 gives us ground to assume that there too we have, in all probability, to do with the induction of polyploid shoots and flowers.

The method here described of obtaining tetraploid races in flax is exceedingly simple and necessitates a minimum expenditure of time and labour. An undoubted advantage of this method over that of soaking the seeds in a colchicine solution is the fact that by immersing the above-ground parts of flax seedlings in colchicine we did not once have a case of a plant being killed. This makes it possible to treat with colchicine, for the purpose of chromosome doubling, rare, even solitary seedlings, without risk of their perishing, whereas such risk is very great, when the method of soaking the seeds in a colchicine solution is used.

The ease of experimentally producing tetraploid races of flax puts to the fore the problem of testing the practical importance of tetraploid races in breeding work. It is probable that a number of the characteristics of polyploids (changes in physiological properties, changes in crossability with allied species, increase in size of seeds and vegetative parts, etc.**) would make tetraploid races of flax superior to existing diploid races.

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REFERENCES

[1] A. F. Blakeslee a. A. G. Avery, Journ. Hered., 28, 393—411 (1937). [2] G. Tischler, Tabulae Biologicae, 7, 109—226 (1931). [3] A. Müntzing, Hereditas, 21, 263—378 (1936).

* A test of the ability of the polyploid pollen to germinate in vitro was made by L. N. Kokhanovskaya, who has elaborated a method of germinating flax pollen, which does not germinate on the usual media (sugar solution, with or without the addition of agar-agar or gelatin).

** See Müntzing's paper [3].

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*PLANT PHYSIOLOGY*

# EFFECT OF FLUORINE SODIUM ON THE FORMATION OF CITRIC AND GLUCONIC ACIDS OF THE FUNGUS *ASPERGILLUS NIGER*

By SERGIUS LVOFF and G. M. TOUPIZINA

*(Communicated by A. A. Richter, Member of the Academy, 13.IX.1938)*

Mould fungi, which produce organic acids under aerobic conditions, generally show under anaerobic conditions a capacity to alcohol fermentation. The adherents of the fermentation theory of formation of organic acids (Bernhauer, Chrzaszcz and others) believe that both processes (acid formation and fermentation) are in close genetic connexion and start with the same reactions, which diverge only later on, in dependence on the presence or absence of oxygen, i. e. they consider acid formation as a process substituting alcohol fermentation. Butkevich and other advocates of the theory of direct oxidation reject the connexion between these two processes (at least with regard to citric acid) and admit that acid formation and fermentation proceed quite independently, each following its own channel. Bernhauer (2) ascertained by means of sulphite method the formation of acetic aldehyde under aerobic conditions, when normally acid formation takes place. Criticizing Bernhauer's views, Butkevich (3) indicates that fixation of acetic aldehyde in perceptible amounts is observed, mainly, in those races of *Aspergillus niger*, which are poor acidformers. According to his statement, the ability of a race to active fermentation is usually combined with reduced energy of acid formation and vice versa, i. e. there exists no parallelism between these two processes. In connexion with this it is worth noting here that the same lack of parallelism (only with regard to fermentation and respiration) may be observed in the various races of yeast (wild and cultural forms)—a circumstance which can by no means be considered as an argument against the idea of genetic relation between respiration and fermentation. The explanation of this phenomenon lies in the fact that vigorously fermenting cultivated forms usually possess a weakly active oxidating apparatus.

Though Butkevich, while developing his conception of the chemism of citric acid formation, kept within these relatively narrow limits, nevertheless his point of view, it is quite evident, adheres closely to the views which have been developed since 1930 by Lundsgaard. The latter, as it is khown, succeeded (6) in proving that fermentation can be completely stopped in muscular tissue and in yeast without breaking off respiration. A deduction was made on this ground, that the reactions underlying the processes of oxidation (respiration) are in no connexion with fermentation reactions, both processes proceeding quite independently.

may see, the difference between the limiting concentrations is rather slight and may be easily explained by the reason mentioned above.

In the experiments described below, with the mould fungus *Aspergillus niger* we used NaF which is, in general, analogous to monochloroacetic acid. We did not set ourselves the purpose of defining the limiting concentrations of fluorine sodium which break off fermentation and oxidation, since on the ground of considerations referred to above we attached no great importance to this question. All our experiments were conducted under aerobic conditions, our task being to elucidate the question, whether the presence of NaF would affect in the same way the production of citric and gluconic acids, the latter of which is formed, doubtless, by means of direct oxidation, while as to the former this remains still unsettled. The method for these experiments, as well as the methods of definitions, were the same as in the previous work by Lvoff and Limberg (7).

The fungus films were grown during 48 hours, after which under these films (after their careful washing) were introduced the solutions of 20% saccharose without NaF (control) and with different concentrations of NaF (concentrations are everywhere expressed in moles per 1 litre). The dry weight of a film was determined in special flasks prior to the experiment (this initial film weight was taken in our calculations for 100). All the figures are averaged from two parallel experiments. The results of six experiments are given in the following tables. Duration of the second experiment was 45 hours, of the third—41 hours, of all the remaining—42 hours (see the tables of 6 experiments).

It is clear from these tables, first of all, that all the concentrations of NaF, beginning with the minimum ones, cause some lowering of vital activity of the films, which results in decrease of total acidity and of sugar consumption in the solution (only with the lowest concentration $10^{-5} \times 1.5$ M. in the first experiment the consumption of sugar was equal to that of the control).

The production of citric acid begins to decrease as well with the minimum concentrations of NaF, this abatement ever progressing with the concentration rise. Along with this, the critical concentration may be distinctly established which results in a sharp depression of citric acid production. This critical concentration is found between $10^{-5} \times 5$ M. and $10^{-4} \times 7.5$ M. (slight variations are caused by different physiological state of the fungus in the experiments conducted at different times).

Gluconic acid behaves quite differently. With low concentrations of NaF it not only experiences no depression (the control figure 2.89 g for gluconic acid in the first experiment is, doubtless, exaggerated, but on the contrary, it greatly increases as compared to the control, this increase being observed just with the same concentrations of NaF, with which sets in a sharp depression of citric acid ($10^{-5} \times 5$ M. and $10^{-5} \times 7.5$ M. in the experiments 2, 3 and 5). Citric and gluconic acids are to some extent antagonists with regard to NaF and behave, at any rate, quite differently. High concentrations of NaF, ultimately, cause depression of gluconic acid as well, the critical concentration (the lowering by 50%) being, as we may conclude on the ground of the 6th experiment, $10^{-3} \times 2.5$ M. Thus, between the critical concentrations of citric and gluconic acids there exists an interval which corresponds, approximately, to the interval between the critical concentrations for fermentation and respiration (see above).

A film placed on the solution of saccharose alone (control) increases considerably its dry weight (1½ times in the 3rd experiment as maximum). Fluorine sodium, beginning with the minimum concentrations, weakens these synthetic processes—the dry weight gradually falls coming back,

| Concentration NaF in mol. per 1 litre | Sugar consumed in g Abs.—in % | Acidity in cm³ of $\frac{n}{10}$ alkali Abs.—in % | Citric acid in g Abs.—in % | Gluconic acid in g Abs.—in % | Dry weight of a film in g Abs.—in % of initial |
|---|---|---|---|---|---|
| **Experiment 1 (initial dry weight of a film—2.0487 g)** | | | | | |
| 0 | 11.78—100 | 869.0—100 | 3.82 —100 | 2.89 —100 | 2.7465—134 |
| $10^{-5}\times1.5$ | 11.88—100.8 | 779.5— 89.7 | 3.10 — 81.2 | 2.46 — 85.2 | 2.6327—128.5 |
| $10^{-5}\times2.5$ | 11.50— 97.6 | 706.5— 81.3 | 2.84 — 74.3 | 2.46 — 85.2 | 2.6487—129.2 |
| $10^{-5}\times3.5$ | 10.4 — 88.3 | 652.5— 74.9 | 2.64 — 69.1 | 2.58 — 89.3 | 2.6014—127 |
| $10^{-5}\times5$ | 10.1 — 85.8 | 344.8— 39.7 | 1.17 — 30.6 | 2.51 — 86.8 | 2.3776—116 |
| **Experiment 2 (initial dry weight of a film—3.3312 g)** | | | | | |
| 0 | 12.45—100 | 1161.2—100 | 3.86 —100 | 1.99 —100 | 3.7463—112.5 |
| $10^{-5}\times5$ | 10.22— 82 | 617.5— 53.2 | 1.50 — 38.8 | 2.14 —107.5 | 3.3215— 99.7 |
| $10^{-5}\times7.5$ | 9.04— 72.6 | 256.7— 22.1 | 0.74 — 19.2 | 2.10 —105.5 | 2.8614— 85.9 |
| **Experiment 3 (initial dry weight of a film—1.6912 g)** | | | | | |
| 0 | 9.05—100 | 880.5—100 | 2.70 —100 | 1.60 —100 | 2.5207—149 |
| $10^{-5}\times$ 7.5 | 7.75— 85.6 | 244.4— 27.7 | 0.76 — 28.3 | 2.66 —166 | 2.0427—120.8 |
| $10^{-5}\times10$ | 8.10— 89.5 | 137.5— 15.6 | 0.39 — 14.5 | 1.95 —123 | 1.9925—117.8 |
| $10^{-5}\times12.5$ | 8.30— 91.7 | 135.7— 15.4 | 0.34 — 12.6 | 2.38 —146 | 2.1750—128.6 |
| **Experiment 4 (initial dry weight of a film—1.8582 g)** | | | | | |
| 0 | 11.28—100 | 739.3—100 | 2.51 —100 | 1.62 —100 | 2.6766—144.4 |
| $10^{-5}\times$ 5 | 11.23— 99.6 | 734.8— 98 | 2.65 —105.6 | 1.55 — 96.1 | 2.4490—131.8 |
| $10^{-5}\times10$ | 9.80— 86.9 | 133.3— 18 | 0.62 — 24.7 | 1.75 —108 | 2.1470—115.5 |
| $10^{-5}\times15$ | 9.53— 84.5 | 79.5— 10.7 | 0.285— 11.4 | 1.40 — 86.4 | 1.7359— 93.4 |
| **Experiment 5 (initial dry weight of a film—2.1260 g)** | | | | | |
| 0 | 13.7 —100 | 1035.5—100 | 4.45 —100 | 1.91 —100 | 2.7100—127.5 |
| $10^{-5}\times$ 7.5 | 9.5 — 70 | 215.2— 20.8 | 0.66 — 14.9 | 3.16 —165.4 | 2.1816—102.6 |
| $10^{-5}\times10$ | 9.7 — 70.7 | 146.2— 14.1 | 0.45 — 10.2 | 2.26 —113 | 2.0596— 96.9 |
| $10^{-5}\times12.5$ | 9.05— 66 | 74.7— 7.2 | 0.26 — 5.8 | 1.98 —104 | 1.8835— 88.6 |
| $10^{-5}\times15$ | 8.45— 61.7 | 67.9— 6.5 | 0.26 — 5.8 | 1.72 — 94.8 | 1.7398— 81.8 |
| **Experiment 6 (initial dry weight of a film—2.5205 g)** | | | | | |
| 0 | 10.45—100 | 694.7—100 | 2.73 —100 | 2.58 —100 | 3.1240—124 |
| $10^{-5}\times$ 25 | 9.45— 90.4 | 51.1— 8 | 0.235— 10 | 1.23 — 47.7 | 2.3217— 92.1 |
| $10^{-5}\times$ 50 | 7.85— 75.1 | 21.8— 3 | 0.293— 10.7 | 0.995— 39 | 2.0335— 80.7 |
| $10^{-5}\times100$ | 6.83— 65.3 | 28.6— 4 | 0.395— 14 | 0.487— 18.8 | 1.7076— 67.7 |

first to its initial level (with average concentrations of NaF) and then sinking below it, which indicates that disintegration reactions in the film begin to prevail over the reactions of synthesis. In connexion with this, another interesting distinction is revealed between citric and gluconic acids. While the production of citric acid sharply falls long before the cessation of synthetic processes in the fungus film, i. e. when the dry film weight is still continuing to grow, as compared to the initial weight, the depression of gluconic acid production sets in only after disintegration processes having definitely prevailed over the processes of synthesis, i. e. when the dry film weight markedly decreases, as compared to the initial weight.

This essential distinction between citric and gluconic acids suggests that the processes of their formation are quite different, and that therefore

it could hardly be possible to apply the theory of direct oxidation to both these acids. On the ground of the critical considerations above expounded and of the facts stated in our two papers, we come to a conclusion that there exist at present no serious arguments against the fermentation theory and that the rejection of it by its former adherent Walker was, at least, premature.

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REFERENCES

[1] Баринова и Буткевич, Микробиология, **5**, 768 (1936). [2] Bernhauer u. Thelen, Bioch. ZS., **253**, 30 (1932). [3] Буткевич, Менжинская и Трофимова, Микробиология, **3**, 319 (1934). [4] Ehrenfest, Journ. biol. Chem., **100**, XXXVIII (1933). [5] Johnson, Knight a. Walker, Bioch. Journal, **31**, 903 (1937). [6] Lundsgaard, Bioch. ZS., **217**, 162 (1930); **220**, 18 (1930); **227**, 51 (1930); **250**, 61 (1932); Ergebnisse d. Enzymforschung, **2**, 179 (1933). [7] Lvoff a. Limberg, C. R. Acad. Sci. URSS, XXI, № 4 (1938). [8] Nilson, Zeile u. Euler, ZS. f. physiol. Chemie, **194**, 53 (1931). [9] Southers a. Walker, Bioch. Journal, **26**, 317 (1932). [10] Turner, New Phytol., **36**, 142 (1937).

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*PALEONTOLOGY*

# THE AZOV HORIZON OF KUBAN

By A. G. EBERZIN

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During the investigation of the Kerch iron-ore deposits in 1928—30, at the base of Kimmeridgian deposits of the Kerch peninsula an independent stratigraphic horizon was identified ([4],[5]).

In a joint paper with N. B. Vassoevich on the stratigraphy of the Middle Pliocene of the Black Sea it was designated (by the locality of its typical outcrops) by the name of «Azov horizon» ([1]).

The deposits of this horizon are overlying the uppermost strata of the Pontian (horizon I Kamysh-burun) and immediately underlying the ore-deposits of the Kimmeridgian stage. They are characterized by a peculiar fauna, which contains alongside of forms of the Pontian character (for instance. *Didacna* aff. *paucicostata* Desh.. *Kaladacna steindachneri* Brus. etc.) Kimmeridgian guide-species: *Dreissensia iniquivalvis* Desh., *Didacna crassatellata* Desh.. *D. multistriata* Rouss., *D. gurievi* Desh., *Paradacna stratonis* Andrus., *Pteradacna edentula* Desh. etc., as well as species solely characteristic of the Azov horizon: *Dreissensia brusinai* Andrus., *Dr. huoti* Andrus.. *Arcicardium subacardo* Andrus., *Didacnomya corbuloides* Desh. var. *major* Andrus., *Prosodacna prionopleura* Andrus. typ., *Pr. obovata* Andrus., *Pr. inflatissima* Andrus., and new species: *Monodacna akmanaica*. *Panticapaea praeduboisi*, *Paradacna deformis* and others.

Deposits of the Azov horizon are widespread on the Kerch peninsula. They occur. besides. on the Taman peninsula ([1]) and in Abkhazia ([2]).

It would be natural to presume that the Azov horizon is also developed within the boundaries of the Kuban province. However, except one single reference made by S. I. Charnotzky ([3]) to but one locality in the Ilsk district which could be assigned to this particular horizon, no other data regarding these deposits are available in literature.

It became possible to fill this gap only in the summer of 1938, when I had an opportunity of visiting some places in the Krasnodar region and establish there a number of outcrops of the Azov horizon.

The Kaluga oil-district is identified as the eastern point where I observed the Azov horizon. Over there along the left bank of the river Ilyitch, by the mouth of the Kamyshev ravine and its affluents, are exposed strata of bluish-grey arenaceous clays and sands a score or two meters in thickness. In the sands and clays were found: *Dreissensia anisoconcha* Andrus. typ., *Dr. anisoconcha* Andrus. var. *kitenica* Andrus., *Dr. rostriformis* Desh., *Dreissensiomya aperta* Desh., *Didacna subcrenulata* Andrus., *D. paucicostata*

Desh., *D. sulcatina* Desh., *D. incerta* Desh. typ., *D. incerta* Desh. var. *fragilis* Andrus., *Didacnomya corbuloides* Desh., *Kaladacna steindachneri* Brus., *Limnocardium subsquamulosum* Andrus., *L. subsyrmiense* Andrus., *Monodacna subdentata* Desh., *Paradacna abichi* R. Hörn., *P. retovskii* Andrus., *Phyllicardium planum* Desh., *Plagiodacna carinata* Desh., *Prosodacna semisulcata* Rouss., *Pr. fischeri* Andrus., *Pr.* gr. *rumana* Font., *Pr.* gr. *macrodon* Desh., *Pisidium* sp., *Lymnea* sp., *Melanopsis* sp., *Viviparus* sp., *Valenciennesia* sp. and others.

Stratigraphically (above the horizon with *Congeria subrhomboidea* Andrus.,) and faunistically (*Didacna incerta* Desh. var. *fragilis* Andrus., *Prosodacna fischeri* Andrus., *Didacna paucicostata* Desh., *D. subcrenulata* Andrus., contained in various successive interbeds from the base upwards) these beds correspond to the full measure of the Upper Bosporan sub-stage of the Pontian (I—IV Kamysh-burun horizons).

Above the uppermost layers of the described rocks, occasionally separated from them by thin, irregular, pinching out pebble-beds, are lying deposits of the Azov horizon (the lower division of the Kimmeridgian stage). These deposits are represented by a series of argillaceous sands and arenaceous clays, with a prevalence of brownish shades, sometimes with thin ferruginous interbeds. The visible thickness of the indicated areno-argillaceous series, lithologically similar to the Upper Pontian beds, is not less than 10—12 m. It carries the following forms of fauna: *Dreissensia angusta* Rouss., *Dr. iniquivalvis* Desh., *Dr. rostriformis* Desh., *Dr.* cf. *rostriformis* Desh., *Chartoconcha bayerni* R. Hörn., *Didacna* aff. *paucicostata* Desh., *D.* aff. *multistriata* Rouss., *Didacnomya corbuloides* Desh., *Kaladacna* aff. *steindachneri* Brus., *Limnocardium* aff. *squamulosum* Desh., *L. subsyrmiense* Andrus., *Prosodacna* gr. *macrodon* Desh., *Pr. inflatissima* Andrus., *Pr. prionopleura* Andrus., *Pr.* cf. *metoica* David., *Pr. semisulcata* Rouss., *Pr.* sp., *Monodacna lebedinzevi* Andrus., *M.* cf. *sokolovi* Andrus., *Phyllicardium planum* Desh., *Bythinia cyclostoma* Rouss., *Viviparus* sp., *Micromelania* sp.

Stratigraphically higher than the Azov beds there appear unfossiliferous sands in the district of Kaluga. In the part immediately succeeding the Azov horizon are observed numerous thin layers and crusts, as well as concretions of brownish ferruginous sandstone and brownish ferruginous spots. The abundance of ferriferous formations in the given part of sands may lead to the suggestion that these sands still refer to the Kimmeridgian stage, corresponding, perhaps, to the ore deposits developed in the western part of the Kuban province and absent in the eastern part of the latter.

Considering the marked thickness of the Azov deposits in the district of Kaluga, it may be assumed that these deposits extend far beyond the boundaries of this particular region to the east and westward.

For want of actual data, it is difficult to judge about the eastern border of their development. Only from general paleogeographic data regarding the Pliocene of the Kuban province, it may be believed that they spread eastward not farther than to the Pshekha river.

As to their westerly expansion, the following is true. To the west of the Kaluga district the Azov horizon is traced within the sheet of Smolensk. Thus, in the region of the Shebsh river, at the top of Pontian deposits, in grey argillaceous sands occur *Didacna crassatellata* Desh., *D.* sp., *Didacnomya corbuloides* Desh., *Monodacna akmanaica* Ebers., *M.* sp., *Phyllicardium planum* Desh. Then from the collections of A. A. Shmelev, determined by me, it has been established that in the Kaustov ravine (left affluent of the Topchiev ravine) directly above the Upper Pontian brownish sandstones (with *Dreissensia rostriformis* Desh., *Dr.* cf. *anisoconcha* Andrus., *Didacna suberassatellata* Desh., *D.* cf. *depressa* Desh., *D.* ex gr. *planicostata* Desh., *Didac-*

*nomya* cf. *corbuloides* Desh., *Limnocardium subsquamulosum* Andrus., *Plagiodacna carinata* Desh., *Posodacna* cf. *semisulcata* Rouss., which correspond in age to the horizon of Kamysh-burun I) are resting grey micaceous argillaceous sands of the Azov horizon with *Dreissensia theodori* Andrus., *Didacna* aff. *paucicostata* Desh., *Prosodacna* cf. *obovata* Andrus., *Pr. prionopleura* Andrus., *Panticapaea praeduboisi* Ebers.

Further to the west, in the sheet of Ilsk the deposits of the Azov horizon are distinguished by considerable development and thickness. Thus, in the exposures along the crevice Shirokaya (ravine) their total thickness exceeds 20 m.

Lithologically they are represented here by bluish-grey sands and clays, occasionally interbedded with sandstones and carrying a rich fauna: *Dreissensia angusta* Rouss., *Dr. iniquivalvis* Desh., *Dr. rostriformis* Desh. var. *akmanaica* Andrus., *Dr. theodori* Andrus., *Dreissensiomya aperta* Desh., *Ckartoconcha* sp., *Didacna crassatellata* Desh., *D.* aff. *paucicostata* Desh., *Didacnomya corbuloides* Desh., *Kaladacna* aff. *steindachneri* Brus., *Limnocardium* aff. *squamulosum* Desh., *L.* gr. *subsyrmiense* Andrus., *Monodacna lebedinzevi* Andrus., *M.* sp., *Paradacna stratonis* Andrus., *P. deformis* Ebers., *Phyllicardium planum* Desh., *Plagiodacna carinata* Desh., *Prosodacna prionopleura* Andrus., *Pr. inflatissima* Andrus., *Pr.* cf. *obovata* Andrus., *Pr.* sp. sp., *Valenciennesia* sp., *Bythinia* sp., *Viviparus* sp., *Neritina* sp., *Melania* sp., *Micromelania* sp., *Melanopsis* sp.

Insufficient exposure, unfortunately, has not allowed to determine what deposits are underlying the Azov beds. The possibility is not excluded for the latter to be considered as transgressive strata, immediately overlying the Upper Cretaceous sediments, the outcrops of which are found near-by.

Still further to the west, in the denudations of the Ovakov ravine (Abinsk sheet) the Azov horizon is represented by sands, sandstones and arenaceous clays, altogether over 10 m in thickness, with a fauna consisting of: *Dreissensia angusta* Rouss., *Dr. iniquivalvis* Desh., *Kaladacna* cf. *escheri* May., *Limnocardium* sp., *Paradacna stratonis* Andrus., *P. deformis* Ebers., etc. At the point indicated above the Azov beds are directly superimposed upon the Upper Pontian with the fauna: *Didacna paucicostata* Desh., *D. planicostata* Desh., *D. sulcatina* Desh., and there is a gradual upward transition to beds with typical Middle-Kimmeridgian fauna.

In the adjacent (westward) Crimean sheet the Azov horizon is traced in the basal parts of the Kimmeridgian deposits at the Moldavansky village. And finally, the westernmost point in the Kuban province, where this horizon has been located by me, is identified in the region of the ravine M. Psif (the Kesslerevo-Varenikovskij sheet). Here, at the base of Kimmeridgian deposits, like in the Moldavansk district, are lying beds with *Dreissensia angusta* Rouss., *Dr. rostriformis* Desh. var. *akmanaica* Andrus., *Didacna crassatellata* Desh., *D. gurievi* Desh., *Didacnomya* sp., *Paradacna deformis* Ebers. typ. et var. *psifica*, etc.*

The above data justify the following statement:

1. The deposits of the Azov horizon (the lower division of the Kimmeridgian stage) are widespread within the boundaries of the Kuban oil-bearing district. Up to date they have been traced from Kaluga to Varenikov district, **over a distance exceeding 90 km.**

2. The thickness of the Azov deposits in the Kuban province up to 20 m and over (Ilsk district) is the maximum thickness of the Azov horizon for **the entire Black Sea basin.**

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* A collection of fauna from the latter locality has been presented to me for determination by A. V. Lyadgin.

3. The Azov beds of Kuban are usually conformably overlying the Upper Pontian deposits; this circumstance, however, does not exclude the possibility of transgression of the Azov horizon in some districts of the Kuban province (Ilsk district).

4. The lithological composition (the prevalence of sands) and faunal characters (conchoidal fauna, sometimes marked by smoothness) point to the shallow-water and sometimes littoral character of the formation of observed sediments of the Azov horizon of Kuban.

5. By the composition of fauna the Azov beds of Kuban stand nearest to the coeval formations of the Kerch peninsula. The following forms are common to both localities: *Dreissensia angusta* Rouss., *Dr. iniquivalvis* Desh., *Dr. rostriformis* Desh. var. *akmanaica* Andrus., *Dr. theodori* Andrus., *Dreissensiomya aperta* Desh., *Chartoconcha bayerni* R. Hörn., *Didacna crassatellata* Desh., *D.* aff. *paucicostata* Desh., *D. multistriata* Rouss., *D. gurievi* Desh., *Didacnomya corbuloides* Desh., *Kaladacna* aff. *steindachneri* Brus., *Limnocardium* aff. *squamulosum* Desh., *L.* gr. *subsyrmiense* Andrus., *M. akmanaica* Ebers., *Panticapaea praeduboisi* Ebers., *Paradacna strutonis* Andrus., *P. deformis* Ebers., *Phyllicardium planum* Desh., *Plagiodacna carinata* Desh., *Prosodacna inflatissima* Andrus., *Pr. obovata* Andrus., *Pr. prionopleura* Andrus., *Valenciennesia* sp., *Viviparus* sp., *Melania* sp., *Bythinia* sp., *Melanopsis* sp., *Micromelania* sp.

6. Characteristic species of the Azov horizon of Kuban, which do not occur in the over- and underlying deposits, are: *Monodacna akmanaica* Ebers., *Paradacna deformis* Ebers., *Panticapaea praeduboisi* Ebers., *Prosodacna inflatissima* Andrus., *Pr. obovata* Andrus., *Pr. prionopleura* Andrus.

In conclusion it may be stated that the enumerated guide-species and the entire complex of the Azov horizon species enable to distinguish it clearly everywhere in the shallow-water and littoral facies.

It is difficult to judge about deep-water facies of the Azov horizon, as well as the whole Kimmeridgian stage, for want of natural exposures. According to material derived by drilling in the north-western part of the Kerch peninsula, deep-water sediments of the Azov horizon are represented by non-fossiliferous clays. Apparently the same phenomenon is observed on the Taman peninsula, whence formations of this kind may as well extend farther eastward.

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REFERENCES

[1] Н. Б. Вассоевич и А. Г. Эбёрзин, Тр. НГРИ, сер. А, вып. 1, 1—40 (1930). [2] С. И. Ильин и А. Г. Эберзин, Тр. НГРИ, сер. Б, вып. 38, 1—27 (1933). [3] С. И. Чарноцкий, Тр. Геол. ком., нов. сер., вып. 91 (1914). [4] А. Г. Эберзин, Отчет о деятельности Ак. Наук СССР за 1929 г., стр. 195. [5] А. Г. Эберзин, Тр. ВГРО, вып. 325, 129—167 (1933).

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